THE NAVIGATOR

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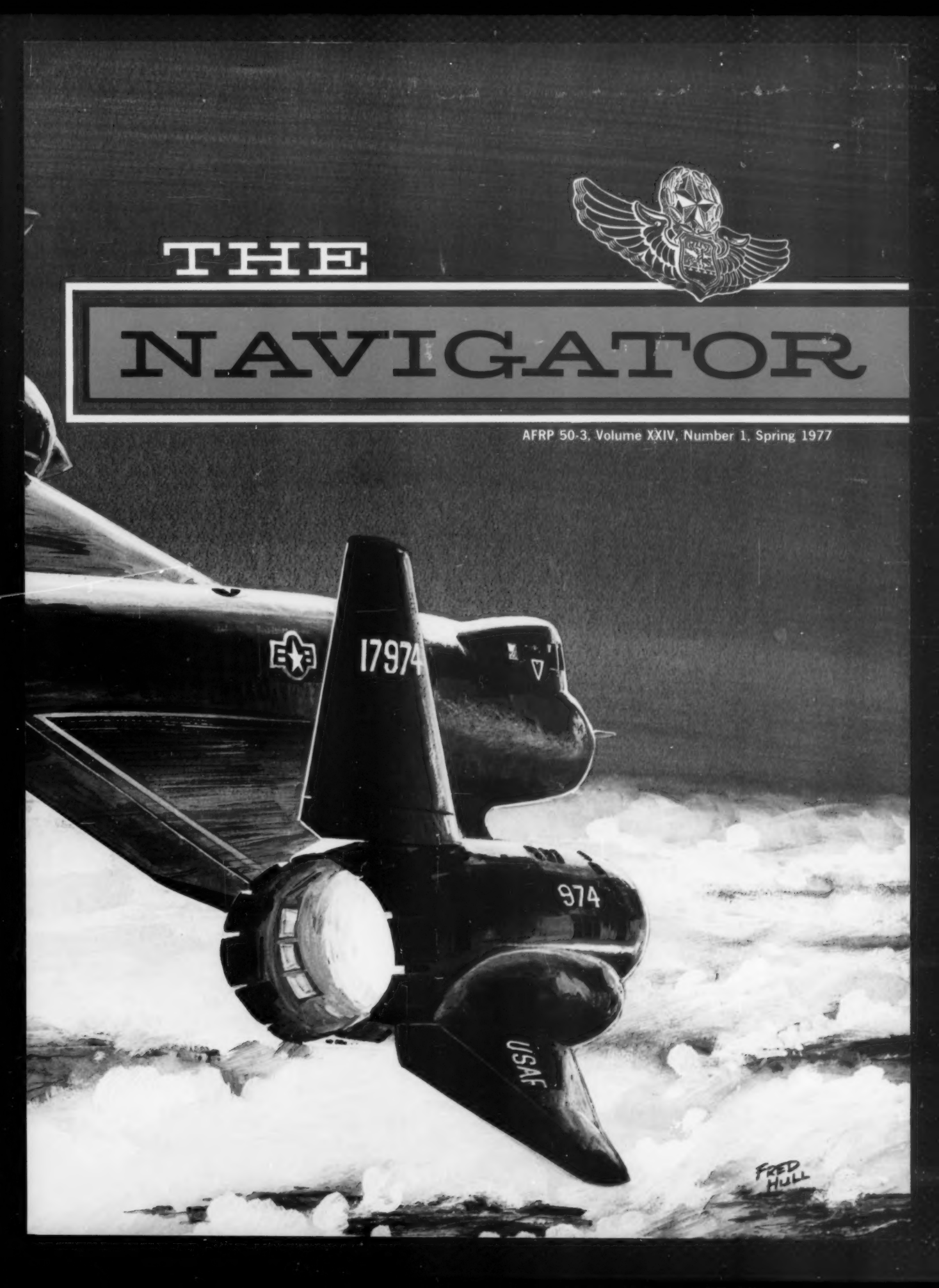


NAV OF NOTE

Colonel Francis R. Fanning is currently assigned as the Assistant to the Deputy Commander for Maintenance in the 381st Strategic Missile Wing at McConnell AFB, Kansas. The 381 SMW is equipped with the Titan II Intercontinental Ballistic Missile Weapon System.

Prior to reporting to McConnell in August 1976, Colonel Fanning completed a four-year tour in the Pentagon, working in the Directorate of Personnel Programs on the Air Staff. One of the primary functions of the Personnel Programs Directorate is to act as the Air Staff focal point for formal training programs conducted by the Air Training Command. Colonel Fanning's duties were primarily associated with ATC's flying training courses; he served successively as the Chief of Survival Training section, Chief of the Navigator Training section, and Chief of the Flying Training Branch. During his Air Staff tour, he was involved in several HQ USAF decisions having significant impact on the navigator training—the elimination of flying from the Electronic Warfare Training and Navigator-Bombardier Training courses, the replacement of the T-29 with the T-43, the introduction of the T-37, Air Force-conducted training for Navy and Marine Corps navigators, and the opening of flying training to women.

Colonel Fanning is a master navigator with over 5,000 flying hours. He has been in the Air Force since 1953. A graduate of the now discontinued Aviation Cadet program, he received his wings in 1954 after completing the Primary Observer Course at Harlingen AFB, Texas, and the Basic Observer-Navigator Course at James Connally AFB, Texas. Following these navigation schools, Colonel Fanning's first assignment as a rated navigator was to Ellington AFB, Texas, as a navigation instructor in the Primary-Basic Observer Course. His duties at Ellington included instructing officers ranging from second lieutenants (just graduated from ROTC courses and totally new to the Air Force) to experienced flyers (with several thousand hours of flying time) who were learning to be navigators after having served as B-36 flight engineers.

During Colonel Fanning's years at Ellington many of those receiving ratings as navigators were assigned to the Strategic Air Command as crew members in the KC-97s, KC-135s, B-47s and B-52s. When navigator training was discontinued at Ellington in 1957, Colonel Fanning joined many of his former students in the long training pipeline leading to combat-ready status as a member of a B-47 crew. His training for SAC began in January 1958 at Mather AFB in the Advanced Navigation-Reconnaissance-Bombardment Course, then to Stead AFB, Nevada, for three weeks of basic survival training, and finally to McConnell AFB for combat crew training.

Upon completing the training pipeline, Colonel Fanning reported to Chennault AFB, Louisiana, in November 1958. Assigned to the 68th Bomb Wing, he served as a B-47 navigator and instructor navigator, squadron navigator, wing navigation and bombing staff officer, and wing scheduling staff officer during the years 1959-1962. He remained at Chennault until the 68th Bomb Wing's B-47s were retired in early 1963. He had the distinction of being the navigator on the ferry crew which flew the last B-47 from Chennault to the Air Force storage facility at Davis-Monthan AFB, Arizona.

After Chennault came an assignment to the 379th Bomb Wing at Wurtsmith AFB, Michigan, as a crew member in the newest aircraft in SAC's bomber inventory at that time, the H model of the B-52. Prior to becoming combat-ready in the B-52, Colonel Fanning spent much of 1963 in training, attending the ASQ-38 Navigator-Bombardier Training Program at Mather AFB and the Combat Crew Training School at Castle AFB, California.

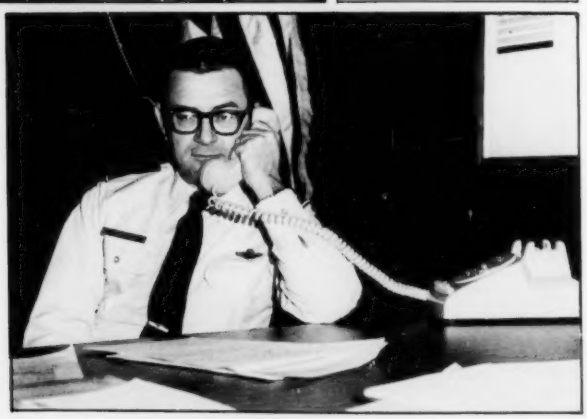
During his tour in SAC's "northern tier" at Wurtsmith, Colonel Fanning was a B-52 Radar Navigator in the 524th Bomb Squadron and a staff officer in the Photo Interpretation and Scheduling Sections of the 379th Bomb Wing staff. One of his most memorable Wurtsmith experiences was his participation in the 1965 SAC Bombing-Navigation Competition as the 379th Wing's bombing and navigation staff officer.

In July 1966, Colonel Fanning departed Wurtsmith and once again became a student—this time as a member of the class of 1967 at the Air Command and Staff College at Maxwell AFB, Alabama. After graduation from ACSC, came RF-4C Combat Crew Training at Mountain Home AFB, Idaho, and assignment in early 1968 to the 12th Tactical Reconnaissance Squadron at Tan Son Nhut Air Base, Republic of Vietnam, as an RF-4C Weapon Systems Operator.

Following the Vietnam tour, Colonel Fanning was assigned to Mather AFB. During the years 1969-1972, he successively served as Element Leader, Assistant Operations Officer, and Flight Commander in the 3540th Navigator Training Squadron, Executive Officer to the Deputy Commander for Navigator Training, and finally, Commander of the 3540 NTS.

Colonel Fanning holds a Bachelor of Arts degree from the University of Houston and a Master of Science in Public Administration from George Washington University.

His decorations include: the Legion of Merit, the Distinguished Flying Cross, the Air Medal, the Meritorious Service Medal and the Air Force Commendation Medal.



From The Editor

READER SURVEY

THE NAVIGATOR Magazine is required by AFR 5-1 to conduct a readership survey every two years. The survey provides trend data on distribution effectiveness and readers' opinion as to the value and effectiveness of the publication. THE NAVIGATOR is the only publication affording navigators a free interchange of ideas and promoting a better understanding and use of Air Force navigator skills and techniques. We ask that you take the very few minutes necessary and complete the enclosed self-addressed, postage-paid survey. This is *your* magazine and we want to serve *your* needs.

Letters to the editor are encouraged and should be addressed to:

Editor, THE NAVIGATOR Magazine
323 FTW/DOTN
Bldg 3875, Stop 21A
Mather AFB, CA 95655

EDITORIAL

Air Force recruiting in FY 76 was highly successful from both quality and quantity standpoints, but several factors have combined to give some concern over the outlook for the future.

Reduced operating and advertising budgets for recruiting, the warming of the economy, fewer recruiters than in FY 75, and increased standards for enlistment have all affected recruiting and made a difficult job much tougher.

In response, Air Force Recruiting Service has kicked off a new effort called the Air Force Recruiter Assistance Program (AFRAP). AFRAP includes a number of measures being taken to extend the recruiters' reach by getting support for recruiting from Air Force individuals and organizations. AFRAP includes a project to get all Air Force people to seek out and refer potential enlistees. To accomplish this, the mail-back coupon (next column) was developed. It can be given to prospective Air Force members who would fill it out and mail it to the Air Force Opportunities Center in Peoria, Illinois. Following verification of the potential recruit's primary interest, Air Force recruiters would contact the young person and further explain Air Force benefits, the dedication and commitment required, and take other measures to ascertain specific desires and qualifications for Air Force duty.

If we can get every Air Force member to identify one or two young people who apparently have the qualifications we seek, talk candidly with them about our great way of life, and urge them to seek additional information from our recruiters, the active duty force of today can play a decisive role in selecting the Air Force leaders of tomorrow.

HELP THE AIR FORCE

help a young person land a great job . . . in the Air Force. Join the Air Force Recruiter Assistance Program and help us find the truly sharp and intelligent young people who meet our high standards. We have openings now for eligible young men and women. If you know one, ask him or her to fill in the coupon below and drop it in the mail. They'll receive additional information about the Air Force as well as the location of their nearest Air Force recruiter. Complete and mail to: *Air Force Opportunities, P.O. Box AF, Peoria, IL 61614.*

1RA017D

Name _____

Address _____

_____ Zip _____

Phone _____

Date of Birth _____ Sex _____

Last School Attended _____

Information Only ____ Please Contact ____

Date of Graduation _____

THE NAVIGATOR

AFRP 50-3, Volume XXIV, Number 1, Spring 1977

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The SR-71 on THE NAVIGATOR cover is the fastest aircraft in the world. One of the world record setters, Major George Morgan has written an interesting and informative article on page 5 about his experience in the SR. We also call your attention to page 8 and the information on the West Coast LORAN C installations.

the Fabulous Blackbird

SR-71

Editor's Note: The author, George Morgan, has flown faster than any other Air Force navigator on record. Strategic Air Command has provided information which pertains to his and other SR-71 record breaking flights.

Three Strategic Air Command SR-71 reconnaissance aircraft broke six records previously held by Soviet MIG-25 and US Air Force YF-12 aircraft during flights on July 27 and 28, 1976.

The aircraft set records for flight over a 1,000 kilometer closed circuit course, over a 15/25 kilometer straight course and for altitude in horizontal flight.

The first record-setting flight came early in the morning July 27, 1976 when Major Adolphus H. Bledsoe, Jr, pilot, and Major John T. Fuller, reconnaissance systems operator (RSO), flew the SR-71 to 2,092 miles per hour. This set new marks for the world absolute and class records for speed over a closed circuit course. The previous record was 1,853 mph, held by a USSR MIG-25 Foxbat.

Flying 2,194 mph July 28, a second SR-71 bettered two records. Captain Eldon W. Joersz, pilot, and Major George T. Morgan, RSO, set world absolute and class speed records over a 15/25 kilometer straight course. The previous record of 2,070.101 mph was held by the YF-12A, prototype sistership of the SR-71.

Captain Robert C. Helt, pilot, and Major Larry A. Elliott, RSO, flew to 85,131 feet July 28, 1976 to set world absolute and class altitude records for horizontal flight. The flight breaks the record of 80,257.86 feet held by the YF-12A.

Major George T. MORGAN
9SRW/DOV
BEALE AFB, CA

"Do you have any information on the SR-71?" This was the question I asked the assignment personnel at Glasgow Air Force Base back in 1966. Not only did they have no particulars, they had never heard of the SR.

The author after the record flight

After quite a bit of haggling I finally convinced them to include the SR-71 on my "dream sheet." We wrote it in even though there was no corresponding number designator for the program.

My friends all thought I was crazy. I was a new 2d Lt navigator, fresh out of Mather, and I hadn't even checked out in the B-52D yet. But I figured I had nothing to lose and almost everything to gain.

After 2600 hours in the B-52D and several hundred days of Arc-Light time, I was approached by the 9th Strategic Reconnaissance Wing (SRW), Beale Air Force Base, about the possibility of an assignment to the SR-71 program.

Next came a very extensive physical at the Brooks Medical Center in San Antonio, Texas (where they start at your toes and 8 days later they're approaching your nose). Upon successful completion of the physical, I was ordered to report to the 9 SRW for an interview with the Wing Commander. I was positive that as soon as I opened my mouth I would "blow" any chance I had at becoming an SR-71 crew member. Much to my surprise, just the opposite happened. In October of 1969, I found myself leaving Dyess Air Force Base, Texas for Beale Air Force Base, California.

Because the SR is such an intricate piece of machinery, the academics and flight simulator training are accomplished at Beale using both Air Training Command and Strategic Air Command instructors. After one year and about 100 hours in the SR-71 flight simulator I was finally ready to go.

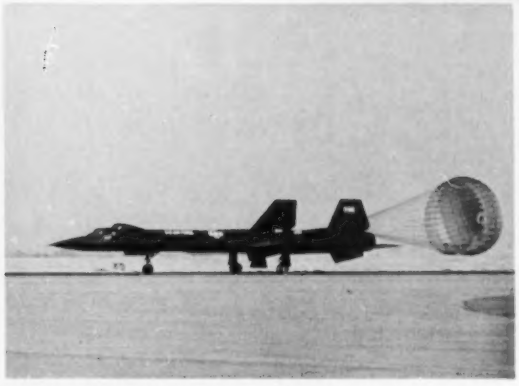
The job of an RSO is quite unique in that it entails a great deal more than just navigation. You become a Navigator, Flight Engineer, Copilot, and an Electronic Warfare Officer all in one. There is no "stick" in the back seat but rather a computer capable of flying the machine in every realm except takeoff and landing.

The navigation system is called the "ANS." It is an inertial system that uses astrological bodies to refine position to a fraction of a mile. The ANS also computes distances, time to run, track offset distance, airspeed, ground speed, etc. It is truly a jack-of-all-trades. Routes can be preplanned and loaded by means of a mission tape or they can be manually entered using a control console located in the cockpit. The preplanned routes can also be manually modified by the RSO if necessary.

In addition to navigating, the ANS also activates various onboard sensors. These sensors also can be operated manually if it becomes necessary. The terminal error of the ANS is extremely small. Because of this, highly accurate course data is available to corrolate sensor products with geographical location. It is an amazingly reliable system.

Many flight instruments are duplicated in both cockpits. Fuel, oxygen, speed, altitude, center of gravity and several others are monitored by both crew members to ensure safe operation and retain a cross check capability that is absolutely necessary.

Several types of photographic sensors are carried in order to satisfy different requirements. Some of these sensors cover wide areas while others are directed against specific areas. The quality of the photographic results can only be described as "fantastic." There are several other sensors carried aboard the SR and the product delivered by these sensors is also extremely accurate and detailed.



Our cruising speeds are in excess of Mach 3 and cruising altitudes are in the realm of 80,000 feet and above. Note that I said "cruising" not "dash." Just recently the SR broke the New York to London speed record by crossing the Atlantic in 1 hour and 56 minutes. Although this was a record, we have been flying these "record-breaking" speeds routinely for years. I sometimes find myself complaining about how "slow" we are going when we are flying at Mach 2.8. I guess all things are relative! Because we do fly at these extreme altitudes we are required to wear a full pressure suit. It is a modified version of the suit worn by the Astronauts during the Gemini missions. Although it looks uncomfortable, it really is quite acceptable in the sitting position and is air-conditioned and form-fitted. I must admit, however, that it would not be the garment to wear at a track meet.

The suit provides another service—protection during bailout. We do not have a capsule in the SR. We use an ejection seat. Should the need to eject arise, the suit would act as our capsule. The suit protects the body against heat and provides the necessary life-support functions to sustain us until we reach a more hospitable altitude of about 15,000 feet.

Every flight in the SR is an experience and I feel very fortunate in having been selected a member of the "Blackbird" team. I have 800 hours in the airplane and I'm afraid my days are now becoming numbered. I am leaving shortly for a school assignment and, believe me, I am not anxious to leave. But I also realize that I must move on and that there are very capable people down the road to fill my slot.

To a new navigator I would offer the following advice: Do the best job you possibly can in any vehicle or system to which you are assigned. Don't ever accept the words "impossible" or "no-chance." Remember, the SR is an amazing result of aerodynamic genius years ahead of its time. The possibility of something being designed that will surpass the SR in speed and altitude is excellent. This means that some young navigator will have to be ready to tackle this new challenge.

Maj Morgan graduated from the State University of New York in 1961 and entered the Air Force as a Weather Observer in Dec 1961. After completing Navigator Bombardier Training, he was assigned to Glasgow AFB with two six-month tours at Andersen AFB in support of Southeast Asia operations. In July 1968, Maj Morgan was transferred to Dyess AFB, followed by tours in Guam and Thailand. He is presently an Instructor Reconnaissance Systems Officer at Beale AFB.

Captain Ralph D. VAN WAGNER
323 FTW/DOYB
MATHER AFB, CA

Captain Donovan, the pilot, softly began singing to himself as he climbed into the top bunk—it had been another long trip for him and his crew. They left home-station in Southern California more than 17 days ago, and finally, they were alerted to head home. The airplane was in good flying shape, but there were a few nav write-ups. Something was written up about the computer, but there was a back-up, and the Nav had only groaned, as he usually did, when scheduled for daytime flights back to the west coast. Donovan dozed off to sleep, his instructions were not to be disturbed until the ADIZ.

Even though he had been asleep, Capt Donovan awoke with a sense of activity. His sleep had been interrupted three times in the last few moments by the sound of the sextant being extended. The last time, the Nav had made such a commotion that Capt Donovan decided he had better check just to make sure everything was still okay. He peeked out from behind the curtain and all looked normal. The Nav was up shooting. The Nav may have been relatively new, but he was a hard worker and was well thought of around the squadron. At about the time he considered going back to sleep, the Nav muttered something under his breath and pulled back from the sextant. Now Capt Donovan could definitely see that something was wrong. Sweat poured off the Nav's face and he was either mad or very worried. Capt Donovan knew the feeling. He had seen and felt it before when he flew the North Atlantic Tracks (NATs) for the first time.

"How we doin', Nav?"

All he got was a glare as he maneuvered out of the bunk. As he slipped into the left seat and hooked up, he glanced at the copilot. Everything seemed all right.

"Where are we, and how much time to blocks?"

"Just passed 135W, ETA to 130 is 2123, and ETA to blocks is 2344. We're about ten minutes behind."

"Everything all right?"

"Yes, couldn't be better, sir."

"Pilot, Nav, things aren't exactly as good as High Speed [the copilot] says. I have a problem."

"What's up, Nav?"

"Sir, I don't know where we are. The number one compass rolled over and died about twenty minutes ago, and the sun is directly overhead."

"What are the computer coordinates?"

"That's the problem, both computers have failed. The primary was written up at Hickam and the secondary works off of the number one compass."

"What about the sextant and LORAN?"

"Well, the sun is almost directly overhead and I can't get a shot."

"What's wrong with your LORAN set? You still have that, don't you?"

"Nothing is wrong with the LORAN set, but there's no LORAN C on the west coast. All I have is CONSOLAN. It gives me a speed line, but my only course line is the Tijuana Beacon."

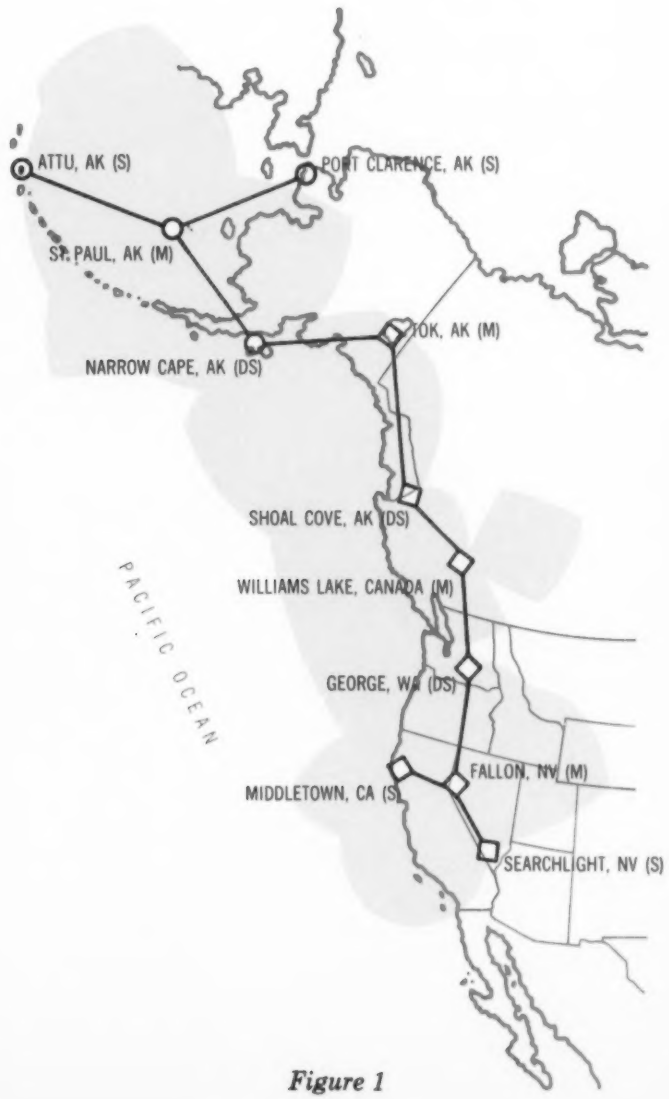
Unfortunately, this scene is drawn from known circumstances. West coast C-141 navigators have confronted this situation daily. They have been punching through the west coast ADIZ on a sunline, CONSOLAN, and anything else they could find.

But things are getting better. Already sites have been surveyed for three new LORAN C chains on the west coast, extending from Tok, Alaska to Searchlight, Nevada. The new chains will fill the gap from 135W longitude to the west coast with not only good coverage but also good cuts. The Department of Transportation, working through the US Coast Guard, had established a proposed operational date of 1 January 1977 for all three chains. The Coast Guard has now announced operational dates for the fully calibrated chains beginning 1 April 1977.

The three chains have been tenatively named the West Coast US Chain, the West Coast Canadian Chain, and the Gulf of Alaska Chain.

The West Coast US Chain will operate on 9940 or SS6. It will be configured with the Master at Fallon, Nevada, Slave W at George, Washington; Slave X at Middletown, California; and Slave Y at Searchlight, Nevada.

LORAN C COVERAGE



LEGEND:

⊙-Existing Station
○-Modified Existing Station
□-New Station
M-Master Station
S-Secondary Station
DS-Double Secondary Station

Figure 1

WEST COAST US CHAIN, Operational 1 April 1977, 9940				
Station Name	Location	Function	Coding Delay	Power
Fallon, Nevada	39°33'06.38"N 118°49'56.20"W	Master 9940		400 KW
George, Washington	47°03'47.90"N 119°44'39.38"W	W 9940	11,000	2 MW
Middletown, California	38°46'56.76"N 122°29'44.30"W	X 9940	25,000	400 KW
Searchlight, Nevada	35°19'18.11"N 114°48'17.35"W	Y 9940	36,000	1 MW
WEST COAST CANADIAN CHAIN, Operational 1 May 1977, 5990				
Williams Lake, BC	51°57'58.70"N 122°22'02.50"W	Master 5990		400 KW
Shoal Cove, Annette, Alaska	55°26'20.68"N 131°15'19.69"W	X 5990	11,000	1 MW
George, Washington	47°03'47.90"N 119°44'39.38"W	Y 5990	25,000	2 MW
GULF OF ALASKA CHAIN, Operational 1 June 1977, 7960				
Tok Junction, Alaska	63°19'42.70"N 142°48'33.30"W	Master 7960		1 MW
Narrow Cape, Kodiak, Alaska	57°26'20.48"N 152°22'11.98"W	X 7960	11,000	400 KW
Shoal Cove, Annette, Alaska	55°26'20.68"N 131°15'19.69"W	Y 7960	24,000	1 MW

Figure 2

The West Coast Canadian Chain will operate on 5990 or SH1. It will be set up with the Master at Williams Lake, British Columbia; Slave X at Shoal Cove, Annette, Alaska; and Slave Y will operate as a dual rated station with 9940W, also at George, Washington.

The Gulf of Alaska Chain will operate on 7960 or SL4. The Master station will be at Tok Junction, Alaska; Slave X at Narrow Cape, Kodiak, Alaska; and Slave Y will also be a dual rated station with 5990X at Shoal Cove, Annette, Alaska. Figure 2 further amplifies the information on these three chains.

This is by no means the end of LORAN C expansion. The Department of Transportation has established termination dates for the existing US-based LORAN A stations. The Coast Guard will be surveying and building LORAN C chains to replace them. The Gulf of Mexico chain will be certified by 1 January 1978; the East Coast chain will be reconfigured, and a new chain, providing coverage in the Great Lakes area, is near completion.

In addition to the US efforts, the Soviet Union is operating a LORAN C chain on 8000 or SL0. The stations are configured with the Master at Oriol, Slave W is at Petrovavodesk, Slave X is at Kuibychev, Slave Y is at Simferopol, and Slave Z is found at Baranovichi.

The implication of LORAN C development is that it very definitely has a future in the world of navigation. The situation that was described earlier should not happen in the future; the West Coast chain was overdue, and now that it is here we will probably see the end of SFI (San Francisco CONSOLAN) soon. LORAN C is changing and it is up to each individual navigator to stay abreast of these changes.

A graduate of Texas Tech, Captain Van Wagner completed UNT in early 1972 and was assigned to C-141s at Norton AFB. While there he compiled over 2500 flying hours and upgraded to Select and Lead Flight Examiner Navigator. In early 1975, Capt Van Wagner was reassigned to Mather AFB where he was a Global Instructor prior to moving to his present position in the T45 Simulator Branch.

TIME DISTANCE GRAPH

Captain Robert E. CHILDRESS
716 BMS
KINCHELOE AFB, MI

There is a need for a simple one-step operation for computing time to travel a specific distance by an aircraft. Presently the navigator must measure the distance to travel using dividers or plotter and then compute this against groundspeed using the Dead Reckoning (DR) Computer to find the time. This equipment and its use are discussed in Air Force Manual 51-40, Air Navigation. Now, the steps I have mentioned can be reduced by using a new device I shall call the Time Distance Graph (TDG). The TDG replaces the dividers, plotter, and DR computer for this function.

The TDG in my example has been developed for use on a B-52H type aircraft but can be adapted for use on almost any aircraft. The built-in groundspeeds are from 360 to 520 knots graphed in increments of 20 knots. The distance is from 0 to 260 nautical miles and the time period from 3 to 37 minutes. The TDG has curves that are plots of time versus distance using specific groundspeeds. The vertical scale is time in minutes and is plotted on one cycle of semilog graph paper to reduce the physical height of the TDG. The horizontal scale is distance and uses the JNC chart scale (shown in AFM 51-40) where one minute of latitude equals one nautical mile. There is one vertical line on the TDG. In the example it is at 28 nautical miles. However, this line will move for different aircraft turn radii. The data for graphing the TDG is in Table 1 and a sample TDG is in Figure 1.

TIME DISTANCE TABLE

GROUNDSPEED → / TIME (MINUTES) ↓	360	380	400	420	440	460	480	500	520
03	018.0	019.0	020.0	021.0	022.0	023.0	024.0	025.0	026.0
04	024.0	025.3	026.7	028.0	029.3	030.7	032.0	033.3	034.7
05	030.0	031.7	033.3	035.0	036.7	038.3	040.0	041.7	043.3
06	036.0	038.0	040.0	042.0	044.0	046.0	048.0	050.0	052.0
07	042.0	044.3	046.7	049.0	051.3	053.7	056.0	058.3	060.7
08	048.0	050.7	053.3	056.0	058.7	061.3	064.0	066.7	069.3
09	054.0	057.0	060.0	063.0	066.0	069.0	072.0	075.0	078.0
10	060.0	063.3	066.7	070.0	073.3	076.7	080.0	083.3	086.7
11	066.0	069.7	073.3	077.0	080.7	084.3	088.0	091.7	095.3
12	072.0	076.0	080.0	084.0	088.0	092.0	096.0	100.0	104.0
13	078.0	082.3	086.7	091.0	095.3	099.7	104.0	108.3	112.7
14	084.0	088.7	093.3	098.0	102.7	107.3	112.0	116.7	121.3
15	090.0	095.0	100.0	105.0	110.0	115.0	120.0	125.0	130.0
16	096.0	101.3	106.7	112.0	117.3	122.7	128.0	133.3	138.7
17	102.0	107.7	113.3	119.0	124.7	130.3	136.0	141.7	147.3
18	108.0	114.0	120.0	126.0	132.0	138.0	144.0	150.0	156.0
19	114.0	120.3	126.7	133.0	139.3	145.7	152.0	158.3	164.7
20	120.0	126.7	133.3	140.0	146.7	153.3	160.0	166.7	173.3
21	126.0	133.0	140.0	147.0	154.0	161.0	168.0	175.0	182.0
22	132.0	139.3	146.7	154.0	161.3	168.7	176.0	183.3	190.7
23	138.0	145.7	153.3	161.0	168.7	176.3	184.0	191.7	199.3
24	144.0	152.0	160.0	168.0	176.0	184.0	192.0	200.0	208.0
25	150.0	158.3	166.7	175.0	183.3	191.7	200.0	208.3	216.7
26	156.0	164.7	173.3	182.0	190.7	199.0	208.0	216.7	225.3
27	162.0	171.0	180.0	189.0	198.0	207.0	216.0	225.0	234.0
28	168.0	177.3	186.7	196.0	205.3	214.3	224.0	233.3	242.7
29	174.0	183.7	193.3	203.0	212.7	222.0	232.0	241.7	251.3
30	180.0	190.0	200.0	210.0	220.0	230.0	240.0	250.0	260.0
31	186.0	196.3	206.7	217.0	227.3	237.7	248.0	258.3	
32	192.0	202.7	213.3	224.0	234.7	245.3	256.0		
33	198.0	209.0	220.0	231.0	242.0	253.0			
34	204.0	215.3	226.7	238.0	249.3	260.7			
35	210.0	221.7	233.3	245.0	256.7				
36	216.0	228.0	240.0	252.0					
37	222.0	234.3	246.7	259.0					
38	228.0	240.6	253.3						
39	234.0	247.0	260.0						

Table 1

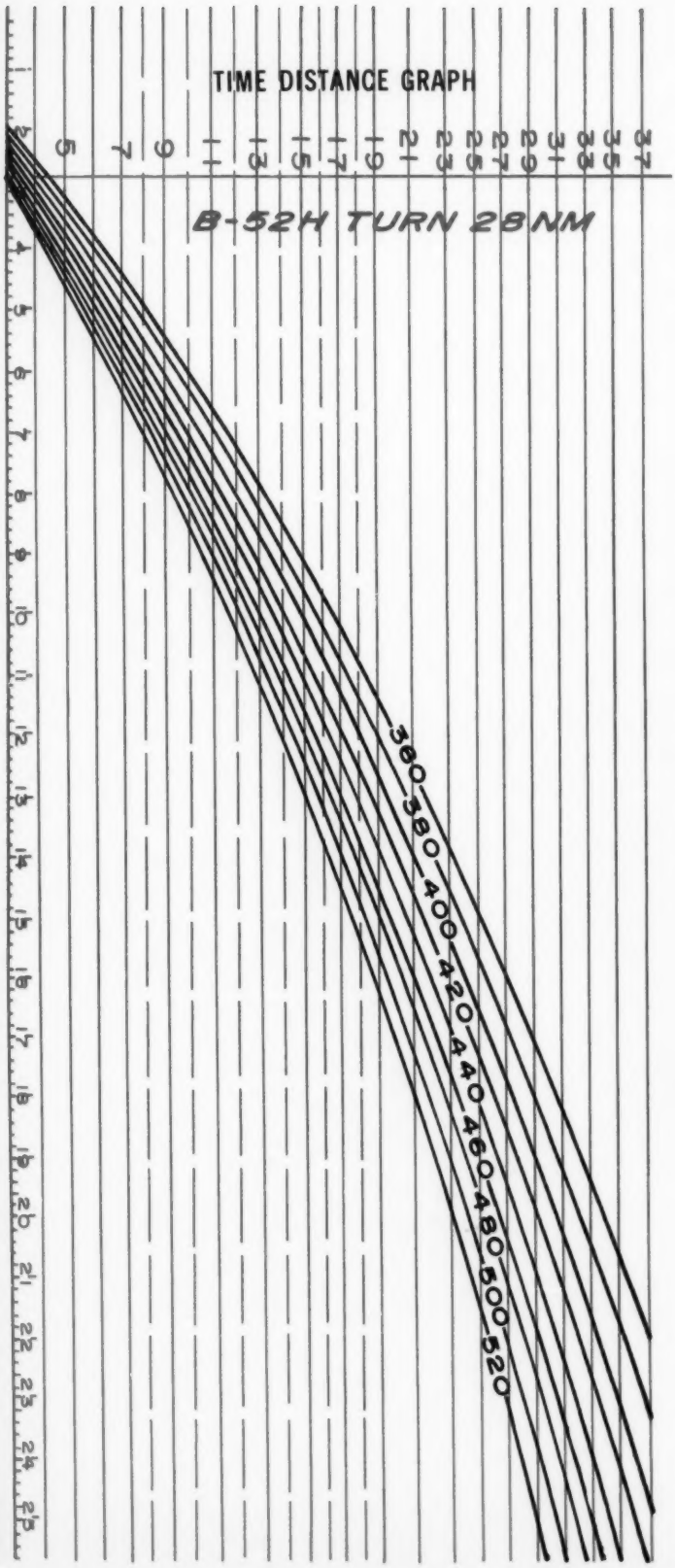


Figure 1

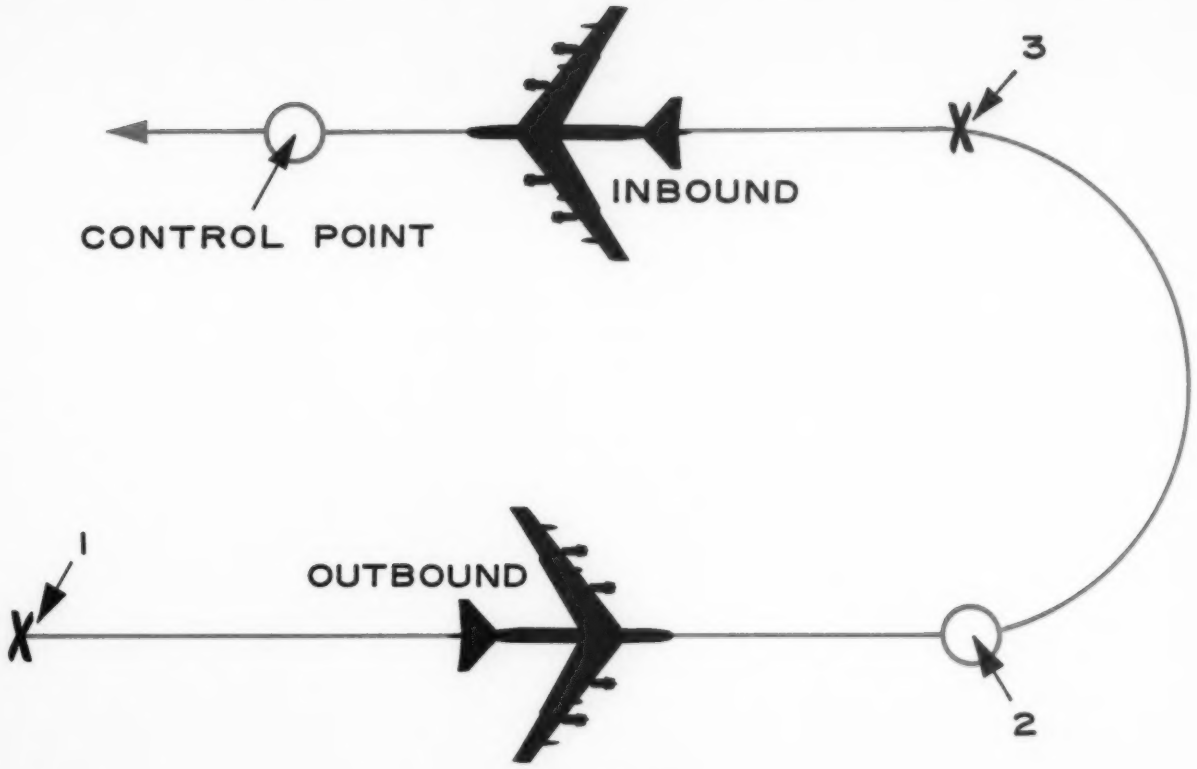
Information necessary to use the TDG includes: the groundspeed, the aircraft's present point on the course line, and the destination on the course line. Place the left edge of the TDG (at 0 nautical miles) on either point, the aircraft's location or destination. The horizontal lines on the TDG are made parallel to the course line. Now, keeping the left edge on that point and the horizontal lines parallel to the course line, slide the TDG until the other point is under the groundspeed desired. The user will read the distance to travel time at the intersection of the course line and the only vertical line on the TDG.

The user may want to travel the distance between the two points in a specific time. Again, the left edge would be on one of the two points and the TDG's horizontal lines are made parallel to the course line. Slide the TDG in the same manner as the last example to place the specific time desired over the course line. Now look to the right at the second position under the groundspeed line for the groundspeed necessary to make the desired time.

Lastly, the TDG may be used in a bit more complicated manner. To explain I must discuss some navigation techniques. Most military flying missions have a point that must be made on time (control time). The navigator must design the mission so that abnormal delays, such as unusual winds, may be absorbed and still make the control time. One technique commonly used is the timing loop. The timing loop is made by planning the outbound course line abeam the control point traveling parallel to the inbound course line (see Figure 2).

TIME DISTANCE GRAPH

Editor's Note: The Time Distance Graph should be reproduced on transparent plastic. This can be done at most base graphic shops on a dry process photo copy machine. If a photocopy machine is unavailable your base photo lab could probably provide you with a positive film copy.



TIMING LOOP
Figure 2

The distance the course line passes abeam the control point is the diameter of a 180 degree turn for the aircraft involved. The diameter used in this example is that of a B-52H using a high altitude standard turn rate. If the aircraft is behind time the length of the loop is shortened or it is extended if early. The trick is to determine the turn point (2). As the aircraft approaches the timing loop, calling the position at about (1), compute the aircraft's inbound groundspeed using the prevailing winds. (The engine power remains constant thru the entire maneuver giving constant true airspeed.) Now to do this using the TDG. The standard high altitude turn for a B-52H using a 180 degree turn gives a perimeter of 28 nautical miles course line distance from (2) to (3). The TDG vertical line is at 28 nautical miles. Place this vertical line over the control point and slide the TDG until point (3) is under the groundspeed curve. Read the estimated time enroute (ETE). Subtract the ETE from the control time to get the desired arrival time at point (2). Use the TDG in the normal manner to find actual arrival at point (2). Next find the difference between arrival and desired arrival. If early, turn later at point (2) by half this difference. If late, turn short of point (2) by half this difference. Without the TDG the navigator has to measure the distances involved and calculate the times using the DR computer.

The TDG can be altered for use on any aircraft or chart. Since aircraft airspeeds vary, the range of groundspeeds may be changed. The scale of the TDG can be varied for different chart scales. Finally, the vertical line used for timing loops may be moved for different aircraft turn radii. The versatility of the TDG permits specialized use for many situations.

Capt Childress graduated from the University of Illinois in June 1969 with a Bachelor of Science degree in Electrical Engineering. He completed Officer Training School in April 1972, and Undergraduate Navigator Training in October 1972. After attending SAC B-52 CCTS at Castle AFB, he was assigned to a B-52 combat crew as a navigator. At the present time, Capt Childress is a B-52 Radar Navigator serving at Kincheloe AFB.

NAVIGATION HISTORY DESERVES A MUSEUM

Captain Kenny N. GIFFARD
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MATHER AFB, CA

On 1 January 1917, a not-so-funny thing happened to a British bomber being flown from Britain to the war in France. The twin-engine Handley Page night bomber landed in a field on the wrong side of the front and, most embarrassing to the British, was captured intact by German troops.

The British aerial observers of this time received less navigation training than the pilots. Basic map reading, compass techniques to derive true direction from the rudimentary compass systems, and elementary astronomy were the navigation subjects of the day, but for this flight the course of instruction was woefully inadequate. Despite the loss of the aircraft and the obvious tarnished pride suffered by the unfortunate crew and British high command, the incident did seem to inform the British that perhaps their means of aerial navigation instruction was less than that desired.

The science of flying was in the infant stage and, accordingly, aerial navigation was lagging in its trail. The earliest of aviators indulged in map reading, primarily relying upon their knowledge of the railroad systems to reach their projected destinations. Sometimes even mastering map reading was not sufficient when one came upon a branch in the track system. For some early air races, the railroads obliged the aviators by designating the proper railroad branch with white paint, trying to steer the aviator in the proper direction. At the last recourse, the aviator could land in the local farmer's field, get directions, and press on anew.

Navigation equipment development began when the frustrated aviators chose to rely less upon the graciousness of the railroad officials, the instructions of farmers, and more on their own resources. Maritime navigation was the source of most of the equipment and the theory applying to mastery of the skies. The Naval compass was modified for use in the airplane. The general type of compass used consisted of a magnetized pointer floating in a liquid-filled bowl. Our present day whiskey compass is a direct descendant of these early compasses. The liquid helped float the compass needle but primarily provided the compass with a dampening medium to limit excessive movement in turns.

Merely transplanting the maritime compass from the ship wasn't the solution to the aviator's heading problems. The aviator soon learned what every old "sea salt" already knew—that the compass was affected by the presence of iron and by the engine operation.

To cope with the first problem, the cockpit area was constructed using a minimum of magnetic materials. Then, like the ships of that era, the aircraft was swung around the compass to determine compass deviation. This compass swing was done with the motors running so an accurate deviation could be found. Various methods were also tried for insulating the compass from engine vibration. These ran from providing a larger bowl of liquid for the compass pointer to float in to using various insulation materials to cradle the compass.

Gimbal-mounted French compass used in the French Breguet aircraft during WW I

The compass was accurate enough to merit regular use even though its best performance came in straight and level, non-turbulent flight. Now the intrepid aviator could use his compass to help determine which railroad line to follow.

The compass systems of this era still suffered from mysterious magnetic forces when the aircraft entered a cloud. Further examination disclosed that the magnetic force affecting the stability of the compass was, in fact, the pilot's inability to navigate straight and level through that medium. Without the luxury of a precise altitude indicator, it is understandable that the flyers of this era had problems penetrating the clouds.

Coincident with the development of the aerial compass came the development of various systems designed to measure airspeed, drift, and altitude. To measure airspeed, the aviators borrowed the wind-measuring technology of the local weatherman. The speed of the air mass through which the airplane flew was measured variously by a series of rotating cups on a propeller whose rotation was translated into airspeed. A flat plate projecting into the windstream was another type of airspeed meter. Airspeed was read as a deflection of the plate but it tended to impact considerable drag on the aircraft. A third and ultimately the most successful method of determining airspeed was a pitot-static system. This method used liquids inside the system whose movement by the air mass was visually translated into airspeed. The problem was that the liquid also moved when acted on by forces of acceleration making the airspeed measurements inaccurate.

Drift was measured by mounting a transparent compass card on the floor of the aircraft. Through the card and a hole in the bottom of the aircraft, the drift over the ground could be seen and measured. Aircraft instability was the major drawback to this system with meaningful drift being almost impossible to obtain.

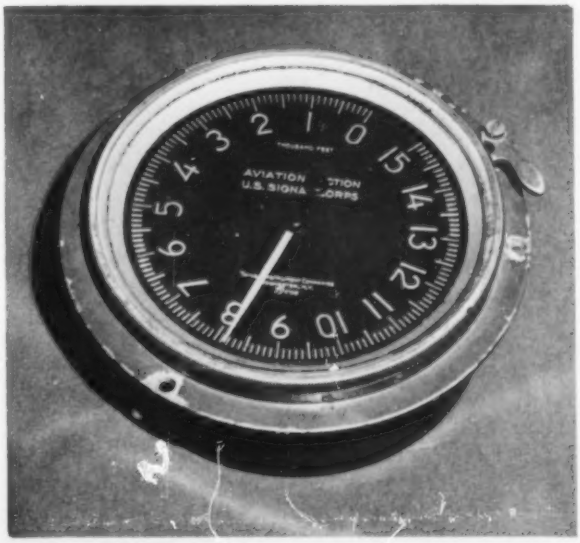
The earliest aviators attempting to measure altitude used a mercury barometer. Since carrying a large barometer in the cockpit was impractical, a small altimeter had to be developed and the aneroid altimeter was the result. On many early flights, the flyer actually wore the altimeter strapped to his leg.

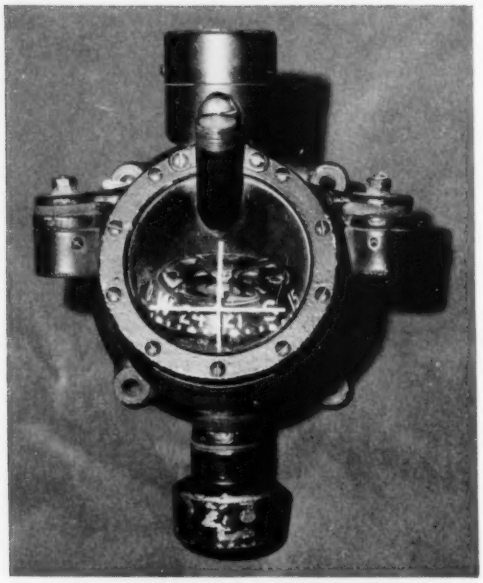
For the purposes of air navigation, determining the absolute altitude was more important than knowing the pressure altitude. Until after World War I, the most common means of determining absolute altitude was accurate map reading to find the local elevation and subtracting that amount from the pressure altitude.

The necessity for a separate navigator/observer came about when the aviator realized that he could not hand-fly the aircraft and accurately navigate. This became more apparent when he tried to fly the aircraft and attain reasonable accuracy in shooting the celestial bodies with the hand-held sextants of that time. Given the state-of-the-art in aerial sextants, the task became almost impossible. Hence, the role of the navigator became distinct from that of the pilot.

As stated, aerial navigation in the early 1900s was in a budding stage. The Silver Wings Exhibit presently can be likened to that early state of navigation development—it also is in the budding

Model 2081A Altimeter used on the JN-4D aircraft during WW I





B-3 Compass used in Army DH-4 aircraft

stage and needs considerable work to reach maturity. Those associated with the Silver Wings Exhibit believe that the history of navigation is very important in the development of aviation. Since Mather AFB is the main source of navigator training for the Department of Defense, it is the logical place to build a Museum of Navigation.

Establishing and accrediting the museum unfortunately can't occur by Wing Commander directive. This must come through a formal request and approval by the ATC/OIC, the USAF Museum, and, finally, the SAF/OIC. Mather AFB supports a large retired population which has shown considerable interest in the creation of a Navigation Museum. The Commander has designated a building to house the Museum and a permanent full time project officer to establish and administer the Museum. Also, the Museum enjoys much support on base. All of these are factors in gaining approval for the Exhibit to become a legitimate Air Force Museum.

To gain credibility, the Museum needs meaningful artifacts for display. The Air Force Museum, Wright-Patterson AFB, has promised its support. However, further sources of artifacts are needed if the Navigation Museum is to be completed.

Another important avenue that the Museum wishes to pursue is establishing a professional navigation library. The Museum would ultimately like to serve as a center for the study of navigation and its history. To disseminate information on the history of navigation (such as that which begins this article) is another proposed function of the Museum and its library.

The proposed method for display of artifacts in the Museum is to provide more than just a description of navigation equipment. The Museum plans to depict the history of navigation through the ages so that a systematic development of both theory and its associated equipment can be traced.

The displays will be built around specific events which were important to the development of the science of navigation and also events which were important in the history of air navigation. Such historic events as the 1926 flight by Lt Comdr Byrd over the North Pole and the World War II air raids on Ploesti are examples.

Those who are interested in this project want to develop the Silver Wings Exhibit into a true navigation museum. The project will develop a viable, professional museum and library for the display of the heritage of navigation. Presently the museum has 10,000 square feet of floor space designated for use. It also has a small collection of navigation instruments representing the early 1900s to the present, but this collection can serve only as a nucleus from which to build a complete collection of historic navigation instruments. The museum needs the support of those people who are interested in maintaining a record of the heritage of navigation.

Your interest in providing support for the Navigation Museum will be appreciated. Donations of historical navigation artifacts or literature for the library should be directed to the Silver Wings Museum, AUTOVON 828-2177, or to THE NAVIGATOR Magazine.

The museum has enormous potential and should be a most positive step in preserving our navigation heritage. We at Mather hope that you will share this enthusiasm with us.

Capt Giffard is a 1969 graduate of the Air Force Academy. Following UNT graduation in April 1970, he went through F-4 RTU and subsequently was assigned to DaNang, RVN. While in SEA, he earned 3 DFCs and 24 air medals. He spent the next four years in stateside F-4Es, followed by assignment as a UNT instructor at Mather in March 1976. Capt Giffard was appointed to his present position as Director of the Silver Wings Exhibit in December 1976.

day celestial fixes ?

First Lieutenant David L. THOMAS
2 BMS
MARCH AFB, CA

I shot my first three-body day celestial fix while still a student navigator at Mather Air Force Base, California. On that particular day not only were the sun and moon at complementary angles to each other, but Venus burned brightly enough in the early afternoon to provide a third line of position and a reliable fix.

It would be nice to say I took the initiative the night before the flight to study the Air Almanac and prepare for those shots. The truth is, I had done all my precomputations for the sun, canned what I could of the other paperwork, and made an early start on those crew rest requirements.

As it turned out the next morning our flight was delayed for maintenance, and we were all left gloomily to watch our precomps expire in the lounge at Base Ops. I was between a coke and a candy bar staring absently at the day's air almanac page when Major Mac (I can't remember his real name), a substitute instructor recently assigned from Military Airlift Command, sat down to talk celestial. As instructor-student conversations go, it was surprisingly informal, but academic, and it wasn't long before I was thumbing through the almanac to check out little observations he seemed to be pulling out of the daily pages. I remember clearly, he could turn to any daily page and read off at a glance which of the listed bodies were up, and when. He even went so far as to predict which planets would have sufficiently different azimuths to be worthwhile shooting. Within half an hour my own incredulity had bought a bad wager, and as our plane took off two hours late, I had in hand precomps for the sun, the moon and Venus.

Major Mac didn't say much about his techniques beyond a few hints, leaving me to discover how he could read so much from the Air Almanac's daily pages. A successful three-body day celestial fix, and these few hints, were enough to get me into the books; and it is rare anymore that I go to the back of the almanac to find what planets are up, if the moon or some planet will be available during twilight, or which of the listed bodies will give the best cuts for a fix.

Two techniques I believe will be useful to navigators planning celestial activity, especially in conjunction with extended overwater flights, are: (1) the determination of the celestial bodies (listed on the daily page) that are available for fixing, and (2) the estimation of their relative azimuth at fix time. All of this information is available at a glance at the almanac daily page if the navigator has a rough idea of his assumed position at fix time.

To determine what bodies will be up, the navigator need only check the GHAs and declinations for his approximate fix time. All bodies with a GHA and declination value within 70^{0} of his assumed longitude and latitude, respectively, will be up. As an example, assume that we are planning to be in the area of 34N 105W, at about 2100Z on 5 May 1975. Any body with a GHA between 035^{0} and 175^{0} and a declination between 90^{0} N and 36^{0} S will be in the sky above us. Checking the daily page (figure 1), we find the sun, Venus, Jupiter, and Saturn will be out. As the GHA of the moon is within 30^{0} of 175^{0}, we can double check moonset and verify that it will set at 2038Z, 22 minutes prior to our planned fix time.

If our celestial leg extends beyond sunset, we can also determine what bodies will be up during twilight. Since we know that GHA increases westward, we may observe that the sun is approximately 42^{0} of GHA west of Venus, which translates into a time (one degree of GHA equals

four minutes of time), of two hours and forty-eight minutes between the times of sunset and Venus set. Thus, after the sun sets in the West, Venus will remain available for celestial navigation for two hours and forty-eight minutes.

Assumed positions of East longitude or of extreme North or South latitudes will present some complications. East longitude must be subtracted from 360° before it can be compared with the GHAs tabulated in the daily pages. In polar latitudes above 70° North or South, the technique becomes unreliable and should not be used.

Although we have determined what bodies are available, we may still hesitate to use them. If Venus is too close to the sun or the moon, it will not be visible. If the moon, sun and Venus positions differ by only a few degrees in azimuth, it will be less trouble and just as accurate to average sun lines.

The only precise way of determining separation and azimuth is to compute them. However, you can estimate which bodies are worth computing by examining their respective GHAs. The GHAs should be a minimum of 30° apart for good separation and azimuth. Where all GHAs are close, the declination of the bodies should be more than 20° apart for good cuts.

As an example, at 1800Z on 5 May 1975 our assumed position is 34N, 105W. Inspection of the daily page reveals that the sun, Venus, Jupiter,

250 (DAY 125) GREENWICH P. M. 1975 MAY 5 (MONDAY)

GMT	☉ SUN GHA	Dec.	ARIES GHA ♈	VENUS −3.6 GHA	Dec.	JUPITER −1.6 GHA	Dec.	SATURN 0.4 GHA	Dec.	☽ MOON GHA	Dec.
h m	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
12 00	0 49.4	N16 09.2	42 44.3	318 12	N25 35	31 57 N	3 26	297 13	N22 31	64 00	S 3 19
10	3 19.4	09.4	45 14.7	320 42		34 27		299 43		66 26	17
20	5 49.4	09.5	47 45.1	323 12		36 57		302 13		68 51	15
30	8 19.5	09.6	50 15.5	325 42		39 28		304 44		71 17	13
40	10 49.5	09.7	52 45.9	328 12		41 58		307 14		73 43	12
50	13 19.5	09.8	55 16.3	330 42		44 28		309 44		76 09	10
13 00	15 49.5	N16 09.9	57 46.8	333 11	N25 36	46 59 N	3 26	312 15	N22 31	78 35	S 3 08
10	18 19.5	10.1	60 17.2	335 41		49 29		314 45		81 00	06
20	20 49.5	10.2	62 47.6	338 11		51 59		317 16		83 26	04
30	23 19.5	10.3	65 18.0	340 41		54 30		319 46		85 52	03
40	25 49.5	10.4	67 48.4	343 11		57 00		322 16		88 18	3 01
50	28 19.5	10.5	70 18.8	345 41		59 30		324 47		90 44	2 59
14 00	30 49.5	N16 10.7	72 49.2	348 11	N25 36	62 01 N	3 26	327 17	N22 31	93 09	S 2 57
10	33 19.5	10.8	75 19.6	350 41		64 31		329 47		95 35	56
20	35 49.6	10.9	77 50.0	353 11		67 01		332 18		98 01	54
30	38 19.6	11.0	80 20.5	355 40		69 31		334 48		100 27	52
40	40 49.6	11.1	82 50.9	358 10		72 02		337 19		102 53	50
50	43 19.6	11.3	85 21.3	0 40		74 32		339 49		105 19	48
15 00	45 49.6	N16 11.4	87 51.7	3 10	N25 36	77 02 N	3 27	342 19	N22 31	107 44	S 2 47
10	48 19.6	11.5	90 22.1	5 40		79 33		344 50		110 10	45
20	50 49.6	11.6	92 52.5	8 10		82 03		347 20		112 36	43
30	53 19.6	11.7	95 22.9	10 40		84 33		349 50		115 02	41
40	55 49.6	11.9	97 53.3	13 10		87 04		352 21		117 28	39
50	58 19.6	12.0	100 23.7	15 40		89 34		354 51		119 53	38
16 00	60 49.6	N16 12.1	102 54.2	18 09	N25 36	92 04 N	3 27	357 22	N22 31	122 19	S 2 36
10	63 19.7	12.2	105 24.6	20 39		94 35		359 52		124 45	34
20	65 49.7	12.3	107 55.0	23 09		97 05		2 22		127 11	32
30	68 19.7	12.5	110 25.4	25 39		99 35		4 53		129 37	31
40	70 49.7	12.6	112 55.8	28 09		102 06		7 23		132 02	29
50	73 19.7	12.7	115 26.2	30 39		104 36		9 53		134 28	27
17 00	75 49.7	N16 12.8	117 56.6	33 09	N25 36	107 06 N	3 27	12 24	N22 31	136 54	S 2 25
10	78 19.7	12.9	120 27.0	35 39		109 37		14 54		139 20	23
20	80 49.7	13.0	122 57.4	38 08		112 07		17 24		141 46	22
30	83 19.7	13.2	125 27.8	40 38		114 37		19 55		144 11	20
40	85 49.7	13.3	127 58.3	43 08		117 08		22 25		146 37	18
50	88 19.7	13.4	130 28.7	45 38		119 38		24 56		149 03	16
18 00	90 49.8	N16 13.5	132 59.1	48 08	N25 36	122 08 N	3 27	27 26	N22 31	151 29	S 2 15
10	93 19.8	13.6	135 29.5	50 38		124 39		29 56		153 55	13
20	95 49.8	13.8	137 59.9	53 08		127 09		32 27		156 21	11
30	98 19.8	13.9	140 30.3	55 38		129 39		34 57		158 46	09
40	100 49.8	14.0	143 00.7	58 08		132 10		37 27		161 12	07
50	103 19.8	14.1	145 31.1	60 37		134 40		39 58		163 38	06
19 00	105 49.8	N16 14.2	148 01.5	63 07	N25 37	137 10 N	3 27	42 28	N22 31	166 04	S 2 04
10	108 19.8	14.4	150 32.0	65 37		139 41		44 59		168 30	02
20	110 49.8	14.5	153 02.4	68 07		142 11		47 29		170 55	2 00
30	113 19.8	14.6	155 32.8	70 37		144 41		49 59		173 21	1 58
40	115 49.8	14.7	158 03.2	73 07		147 12		52 30		175 47	57
50	118 19.9	14.8	160 33.6	75 37		149 42		55 00		178 13	55
20 00	120 49.9	N16 15.0	163 04.0	78 07	N25 37	152 12 N	3 28	57 30	N22 31	180 39	S 1 53
10	123 19.9	15.1	165 34.4	80 36		154 43		60 01		183 04	51
20	125 49.9	15.2	168 04.8	83 06		157 13		62 31		185 30	50
30	128 19.9	15.3	170 35.2	85 36		159 43		65 02		187 56	48
40	130 49.9	15.4	173 05.6	88 06		162 13		67 32		190 22	46
50	133 19.9	15.5	175 36.1	90 36		164 44		70 02		192 48	44
21 00	135 49.9	N16 15.7	178 06.5	93 06	N25 37	167 14 N	3 28	72 33	N22 31	195 14	S 1 42
10	138 19.9	15.8	180 36.9	95 36		169 44		75 03		197 39	41
20	140 49.9	15.9	183 07.3	98 06		172 15		77 33		200 05	39
30	143 19.9	16.0	185 37.7	100 36		174 45		80 04		202 31	37
40	145 49.9	16.1	188 08.1	103 05		177 15		82 34		204 57	35
50	148 20.0	16.3	190 38.5	105 35		179 46		85 05		207 23	33
22 00	150 50.0	N16 16.4	193 08.9	108 05	N25 37	182 16 N	3 28	87 35	N22 31	209 48	S 1 32
10	153 20.0	16.5	195 39.3	110 35		184 46		90 05		212 14	30
20	155 50.0	16.6	198 09.8	113 05		187 17		92 36		214 40	28
30	158 20.0	16.7	200 40.2	115 35		189 47		95 06		217 06	26
40	160 50.0	16.9	203 10.6	118 05		192 17		97 36		219 32	24
50	163 20.0	17.0	205 41.0	120 35		194 48		100 07		221 58	23
23 00	165 50.0	N16 17.1	208 11.4	123 05	N25 37	197 18 N	3 28	102 37	N22 31	224 23	S 1 21
10	168 20.0	17.2	210 41.8	125 34		199 48		105 07		226 49	19
20	170 50.0	17.3	213 12.2	128 04		202 19		107 38		229 15	17
30	173 20.0	17.4	215 42.6	130 34		204 49		110 08		231 41	15
40	175 50.1	17.6	218 13.0	133 04		207 19		112 39		234 07	14
50	178 20.1	17.7	220 43.5	135 34		209 50		115 09		236 32	12
Rate	15 00.1	N0 00.7		14 59.3	N0 00.2	15 02.0	N0 00.2	15 02.2	0 00.0	14 34.9	N0 10.7

Lat.	Moon-set	Diff.
N		
°	h m	m
72	13 06	51
70	13 11	47
68	13 14	44
66	13 17	42
64	13 20	40
62	13 22	38
60	13 24	37
58	13 26	36
56	13 28	35
54	13 29	34
52	13 30	33
50	13 31	32
45	13 34	30
40	13 36	29
35	13 38	27
30	13 39	26
20	13 42	24
10	13 44	22
0	13 47	21
10	13 49	19
20	13 51	18
30	13 54	16
35	13 55	15
40	13 57	13
45	13 59	12
50	14 01	10
52	14 02	09
54	14 03	09
56	14 04	08
58	14 06	07
60	14 07	06
S		

Moon's P. in A.

Alt.	Corr	Alt.	Corr
°	+	°	+
	′		′
0		57	29
9	54	58	28
14	53	59	27
18	52	60	26
21	51	61	25
24	50	63	24
26	49	64	23
28	48	65	22
30	47	66	21
32	46	67	20
34	45	68	19
36	44	70	18
38	43	71	17
40	42	72	16
41	41	73	15
43	40	74	14
44	39	75	13
46	38	76	12
47	37	77	11
49	36	78	10
50	35	79	
51	34		
53	33		
54	32		
55	31		
57	30		
58	29		

Sun SD 15′.9
Moon SD 15′
Age 24d

Figure 1

CELESTIAL PRECOMPUTATION

SHEET NO.

HO-249 PRECOMPUTATION - PERISCOPIC SEXTANT

			ALT MSL		DATE (Z) 5 MAY 75		FIX TIME 1800	Z
DTH	TRACK	°	BODY	SUN	MOON	VENUS		
	GS	K	BASE GHA	090-50	151-29	048-08		
	CORIOLIS	R L	CORR	360		360		
	PREC/NUT	NM / °	SHA					
	DR LAT	34 ° S	GHA	450-50	151-29	408-08		
	DR LONG	105 ° E	ASSUM -W LONG +E	104-50	105-29	105-08		
			LHA	346	046	303		
			ASSUM LAT	34° S	34	34		
			DEC	16 ° S	02 ° N	25 ° S	N S	N S
E L	E L	E L	E L	PLANNED TIME				
				ACTUAL TIME				
				TAB Hc	68-02	33-47	40-12	
*	*	*	*	CORR d +30 DEC 14	-42 15	+25 36		
				Hc				
				TOTAL → ADJ				
	0	0	0	ADJ Hc				
	0	0	0	OFF TIME MOTION				
	0	0	0	Hc				
				Ho				
				INT	T A	T A	T A	T A
				Zn	° 142	° 240	° 086	°	°
				CONV +W ANGLE -E	°	°	°	°	°
				GRID Zn	°	°	°	°	°

TABLE (Condensed)

MSL (Thousands of Feet)

20	30	40	50
400	300	200	110
100	100	90	90
120	90	90	0-40
90	90	9-10	1-30
90	80	9-10	0-40

TIME	TN/GH °	GYRO °	PP. LAT N S	PP. LONG W E

CORIOLIS FACTOR (CF) TABLE

LATITUDE	10°	20°	30°	40°	50°	60°	70°	80° +
CF	.8	.9	1.3	1.7	2.0	2.3	2.5	2.6

CORIOLIS (NM) = (GSK ÷ 100) X CF.
EXAMPLE: LAT = 35° N; GS = 400K; CORIOLIS = 4 X 1.3 = 5NM RIGHT.

Figure 2

Saturn, and the moon will be overhead. Jupiter and Saturn will be too dim to be visible, so we eliminate these bodies from consideration. The sun, moon, and Venus all have GHAs differing by 30^0 or more which is sufficient separation to provide good cuts for a fix. We verify this by precomps with the HO-249, Volume II (Figure 2). All of these bodies are high, with azimuths of 140^0, 240^0 and 086^0 (for the sun, moon, and Venus) at our projected fix time.

The combination of techniques like these will allow the navigator to see at a glance what the sky offers for his celestial planning. But for those with a more theoretical frame of mind, these and other techniques also have the power to open up the world of navigation that lies beyond the routine accumulation of procedures and paperwork, and put a handle on the myriad of figures and computations that at times makes the navigator job almost overwhelming.

1st Lt Thomas graduated from San Francisco State University in 1972. He received his Air Force commission through ROTC, and entered Undergraduate Navigator Training at Mather AFB in February 1973. Next he received specialized training in ASQ-48 systems through Navigator Bombardier Training, followed by assignment to March AFB. Lt Thomas now serves as a navigator with the 2d Bomb Squadron at March AFB.

MANAGEMENT BY OBJECTIVE: A PRACTICAL APPLICATION

Major John F. HECKER
Sacramento ALC/MMIMB
McCLELLAN AFB, CA

With the recent changes in "Title 10," the professional navigator suddenly has an equal opportunity to achieve top-level command status previously denied him by law. There are other changes resulting from the "Equality Revolution" sweeping our country. Women's rights are being expanded, industrial participation in minority hiring is a fact-of-life for big business, and new emphasis is being placed on developing personnel with well-organized, highly trained management skills. Gone are the days of the insensitive, dogmatic, "fear-for-your-career" leadership so prevalent during the 50s and 60s. While this type of leadership was somewhat successful, particularly during periods of crisis, the personnel losses from accelerated attrition, financial irresponsibility, and growing bureaucratic insulation dramatically called for a shift in policy and principle of organizational management.

The navigator, his quest for command insured, must now seek to prepare for future responsibilities by acquiring the skills necessary

to solve the myriad problems associated with command. Perhaps a closer look at the term "command" will clearly indicate what is in store.

Webster's definition of command, if practiced literally, holds the key to certain failure in today's working environment. *"Command: To direct authoritatively, to order, to dominate or overlook, as from a superior position."* Certainly there is a place for the "Command Decision" and we must all agree that the "I'll lead my men into battle" syndrome is probably more interesting. But those days are gone and for good reason. Today's "commander" must be more than a dashing follow-me figure, slipping the surly bonds for the glory of his, and more recently her, ego. He must be a manager. Well then, you ask, what is the difference between a commander and a manager? A wise man once said, "Not all managers are fit for command, but I've never seen a successful commander that wasn't an excellent manager." At the risk of getting into another subject too deeply, I will simply say that the main difference between good commanders and managers is charisma. More than likely this charismatic power was developed along with the management skills. If, at this point, you are worrying about your knowledge of management either from an academic or practical standpoint, don't worry. The rest of this article will give you a foundation for effective management. The public libraries are full of interesting books on management theory and techniques. Masters degrees in management are available through your G.I. benefits. So put your mind at rest, and read on as we develop the practical theory of MANAGEMENT BY OBJECTIVE (MBO).

Management, for most people, is the mystic result of being good at what you do. The reasoning goes like this: Old John Q is the best instructor we have. He deserves something better. We have an opening for a Flight Commander. How about old John Q? The result of the teeth-mashing and political innuendoes is that one day old John Q, the instructor extraordinaire, suddenly becomes mother hen to 10 or 15 other officers, responsible for their problems, their schedules, staff projects, budgets, special projects, etc. Is he ready for his awesome responsibility? Probably not. Our only salvation is to try to prepare for this responsibility as best we can.

MBO is a good start and the best method for planning, organizing, controlling and executing a job or task. The basic premise of MBO lies in the commitment process, and the concomitant dialogue between worker and manager, a good plan of action, and a method of tracking progress and escalating problems. It's that simple. Here is how it works.

Suppose that you are Person B, who works for Person A. You have five people working for you, C-D-E-F-G, who, in turn, have people working for them. Your boss comes to you with a problem, a proposal, or a task directed by his boss. The directions are minimal but the result is well defined, as is the completion date. Your task is to complete the job on time and within budget. How do you do it?

THE PLAN

The first thing you must do is sit down and draw up a rough plan to include scope, milestones, time schedules, and staff involvement. You may have to involve more expertise than is available on your own staff. You then call a meeting of all the participating agencies and present the task to be accomplished. Questions and answers will follow and a second meeting may be required for full understanding. The result you and your staff are looking for is a plan of action that will get the job done. This plan will guide your activity and, in the case of bureaucratic organizations, legitimatize your effort. This will help you get outside support.

This example deals more specifically with middle management and forms the basis for doing business. If MBO is to be instituted on a large scale by a large organization such as a wing, then a word of caution is needed for the colonels and generals: *The system of defining objectives starts at the top—not the bottom.* The colonels and generals know more precisely the covenants that make up the mission. They, in turn, identify their objectives for mission accomplishment and then pass these objectives down to the workers who then establish their goals.

As the plan develops many agreements will be made. These agreements, called commitments, form the basis for the most critical step in any management exercise — getting the people to support your effort.

THE COMMITMENT

The best plan in the world will fail unless those required to insure its completion actively support the effort. Sounds simple doesn't it? Second important fact: *A person who successfully implements a plan and accomplishes the objective is valuable regardless of your personal*

or political feelings about that person. How did this person get the job done? By simply asking and receiving another's word that a certain task would be performed by a certain date.

In securing the commitment, the manager performs a third important task: the STROKE. Here is how the stroke works. The manager discusses with the individual the role that the individual is to play in the plan (dialogue) and asks the individual how this role might best be fulfilled (the stroke). Stroking is the most important thing you can accomplish with another person. If you make the other person feel important, that his opinion is valued, and that you agree with his decision on how to accomplish the task at hand, you have taken a giant step forward in getting your job done. This individual now has a personal investment in getting your plan accomplished and, if he is good, he will work hard to prove that he is responsible and productive.

As you secure a commitment from the individual, you may find that he is not in total agreement with your evaluation of his services. Securing the agreement may require some arbitration or DIALOGUE. Fourth important fact: *Never try to tell another person how to accomplish the task unless he asks.* You want to insure that he understands what the end result should be. He will figure out how to get there. It may not be the best way, but you don't really care as long as you know where he is going. Your next concern is to find a way to check the progress of your plan.

STATUS TRACKING

One of the real "secrets" of good management is learning how to keep track of a project without over-supervising the people. Trying to find out what goes on within an organization probably causes the leaders of organizations more gray hair than any other job related problem. These people know that they are being evaluated partly on their ability to be organized and informed. After all, how can the budding young executive make decisions and exhibit his leadership abilities if he doesn't know what is going on? Well, important fact number five says: *You don't need to know everything that goes on.* That is why you have people working for you. They have to know all the little facts about their tasks. They need to worry about details and solve the everyday problems that come up. You ask, "Well, where do I fit in?" You don't—very often. Your job is to make sure that, first, your man understands what his objective is; second, he knows that he has the authority to make decisions and judgments concerning his task; third, he knows his limits of authority (anyone who has studied Machivellian management techniques knows how flexible this line can become); and, fourth, he has to be aware of his obligation to ESCALATE to you problems arising beyond his sphere of authority.

In order to intelligently escalate his problems, the staff worker must have a tracking system that will allow him to monitor the project's progress in relation to its upper and lower limits and milestones. He designs this system at the same time he makes his commitment. Now the next step is critical. This tracking system must be kept or displayed in the staff worker's office or working area, not in your office. If the system is placed in your office, you can count on two things: (1) duplication of effort because your staff worker will make his own copy of the status system and that means he has two systems to keep updated, and (2) the tendency to escalate problems will diminish since you have the tracking system right in front of you all the time. After all, you can see as well as your staff worker, so he's going to figure if you don't bug him, he's o.k.

It is essential that communication be kept open. To keep track of the various projects under your direct supervision, get out of your office, wander around and look at the systems, chat with the various managers, do a little coaching, and be visible. You'll be amazed at the way your staff will use you as a sounding board, checking your judgment on key issues, getting your opinion on controversial subjects, and generally setting the tone for their staff correspondence. You will know that this system is working when suddenly the quality, tone, and content of the staff writing will drastically improve. You might even say to yourself, "I couldn't have said it any better." Maybe it's because you have already said it that way, and some observant staff officer had his ears open and his brain engaged. Even if the quality of your paperwork improves, you still must face the bane of all management systems—change. How does MBO manage change?

CHANGE

Any time a situation occurs that changes the requirements, milestones, scope, or performance of your players, you must examine all your commitments with each of the committees to see if new commitments are needed. It is not fair for any person to be held responsible for a commitment made before the ground rules changed.

Changes will rarely reduce the requirement on a project team. Usually, some top-level official is trying to keep his boss happy and says "yes" too quickly to a request. Changes can always be included and accommodated in any plan if a little time is taken to find out the impact of the change. Once this is determined, an appropriate reply might be, "Sure, we can incorporate the request in our plan but milestone C will be delayed five working days unless you want to authorize 40 hours of overtime."

Now, you have performed a service for your boss. You have evaluated the problem and provided a realistic appraisal of the impact plus an alternative. The boss can always tell you to do the work anyway. If that happens, there are appropriate options available to you that won't be discussed in this article.

At any rate, you will find that you and your people will be doing a much better job of accomplishing your objectives in addition to higher level staff requests. Now, what happens if the system breaks down—if someone blows his commitment? Discipline is a very real part of MBO. A closer look at its function will round out our study of the practical application of this management system.

DISCIPLINE

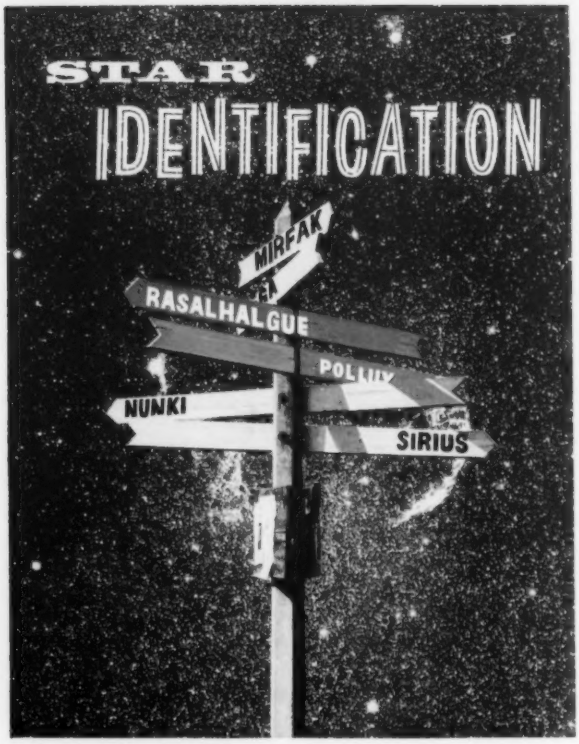
The MBO basic premise and source of strength are that the system allows the staff worker to set individual goals (with your approval) and work toward accomplishing these goals. When the system breaks down, however, it usually will be because the staff worker overstepped his authority in an effort to salvage the plan and then didn't escalate the problem to the boss. This situation must be handled in advance by discussing the consequences with the staff worker. He must understand that if he fails to meet his commitment, or even if he feels that he is not going to make his commitment, he can avert professional disaster by escalating the problem to his boss. He must understand this. This is one rule that he cannot break and if he does, you must take some type of disciplinary action. Usually in civilian industry, where MBO is the practical system, failure to escalate will result in being fired. In government bureaucracies, this isn't always possible but people can be bypassed, organizational structures can be altered, and actions documented. This, of course, is the hard part of being the boss. I don't think anyone really enjoys disciplining another person. However, what happens if the problem is escalated?

This is behavior that you must reinforce. The staff worker followed your direction and escalated a problem that he feels is beyond his authority to solve. Two things must be done immediately. First, you must discuss the immediate "fix", if any, to the problem and, second, revise the plan to insure that all milestone dates are met. You and your staff worker do this together. You will definitely need to renegotiate with all affected agencies because all commitments usually intertwine, but your aim is to get the program back on schedule. If you determine that the program cannot get back on schedule, then guess what you have to do? If you guessed "escalate to your boss," you are getting the idea. You and your staff will have worked an orderly solution to the problem, your staff will have gained confidence in your ability to execute MBO and will be less hesitant to escalate future problems. Let's face it, no one likes to go to the boss with bad news. But, unlike the ostrich syndrome, problems don't get solved unless faced head-on.

When contrasted with Crisis Management (where everyone gathers daily to fight the brightest forest fires and the staff worker has carte blanche to run to his boss with every little problem) MBO offers a measurable savings in all resources required to run a business or accomplish a mission.

Simply restated, you plan your project, get written commitments through dialogue, stroke the people once in awhile, do some coaching, be flexible and accommodate change, and be prepared to discipline people who won't escalate. You will find that management by objective is an exciting way to accomplish a task. It considers all aspects of management and depends on the one resource that makes our country such an exciting place to live—PEOPLE. As you plan your next task, remember that people get the job done so pay attention to your people and they will repay dividends beyond your wildest dreams.

After OTS graduation in 1964, Maj Hecker attended navigator training at James Connally AFB. He flew KC-135s for SAC, C-141s for MAC, and the AC-119 gunship in Vietnam, followed by instructor and staff officer duty at Mather AFB. Maj Hecker was selected for Rated Supplement Duty at Aerojet Solid Rocket Propulsion Company and is currently assigned as Program Manager, Remotely Piloted Vehicle Recovery Systems, Directorate of Material Management, Sacramento Air Logistics Center.



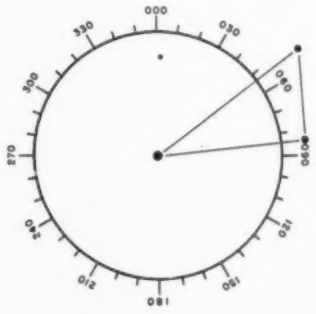
Part 2 of Star Identification includes 12 stars used in HO 249, Volume I. The remaining 13 stars will appear in the summer issue of THE NAVIGATOR.

Each chart shows the first, second, third, and fourth magnitude stars that are visible when the desired star is "centered" in a sextant with a 15° field of view. Lines are included to make the patterns more meaningful. The stars are shown as they would appear from the North Pole. For other latitudes, the accompanying tables of position angles tell how much the charts should be rotated to give the positioning relationship for the time of the observation. Dashes are used to indicate that the star is below the horizon.

To use the charts, enter the tables with the closest values of latitude and LHA of Aries to find the position angle. (Though interpolation can be used, it is not usually necessary to do so.) Then rotate the chart until the position angle is at the top; the star pattern that results is the one that will appear in the sextant.

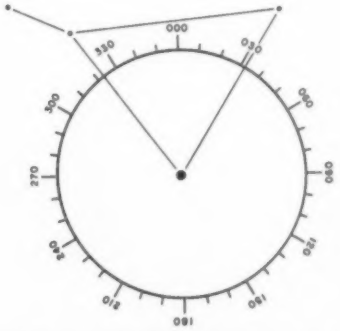
Say, for example, that you want to shoot Menkar and your latitude is 33N and the LHA of Aries is 114. Using 30N and 120 will give you a position angle of 300. Rotate the Menkar chart so that 300 is at the top. With Menkar centered in the field of vision, you will find the identifying "parallelogram" pattern extending to the right.

DENEBOLA



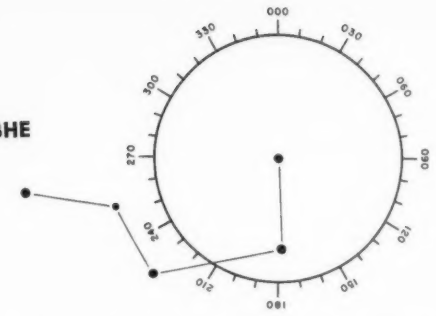
LHA Aries / Lat	0	30	60	90	120	150	180	210	240	270	300	330
80N	000	005	009	010	009	005	359	354	351	350	352	355
70N	-	-	018	021	018	010	359	347	340	340	344	-
60N	-	-	027	031	028	016	357	339	330	330	-	-
50N	-	-	-	042	039	025	356	330	319	320	-	-
40N	-	-	-	052	051	036	353	318	308	310	-	-
30N	-	-	-	062	063	052	348	303	297	300	-	-
20N	-	-	-	072	075	073	328	285	285	290	-	-
10N	-	-	-	081	088	096	224	267	274	-	-	-
0	-	-	-	091	099	116	196	250	263	-	-	-
10S	-	-	-	101	110	132	190	237	253	-	-	-
20S	-	-	-	-	121	143	187	225	243	-	-	-
30S	-	-	-	-	130	151	185	216	234	-	-	-
40S	-	-	-	-	139	157	183	209	224	-	-	-
50S	-	-	-	-	147	162	183	203	215	-	-	-
60S	-	-	-	-	156	167	182	196	207	-	-	-
70S	-	-	-	-	-	171	182	191	-	-	-	-
80S	-	-	-	-	-	-	-	-	-	-	-	-

DIPHDA



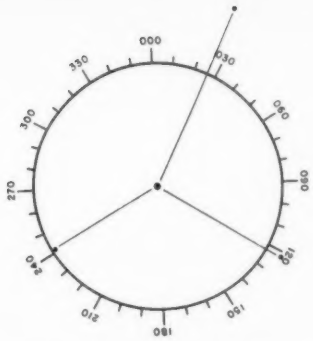
LHA Aries / Lat	0	30	60	90	120	150	180	210	240	270	300	330
80N	-	-	-	-	-	-	-	-	-	-	-	-
70N	003	353	-	-	-	-	-	-	-	-	-	-
60N	005	350	337	-	-	-	-	-	-	-	-	018
50N	007	346	330	-	-	-	-	-	-	-	-	025
40N	009	342	323	-	-	-	-	-	-	-	046	031
30N	011	338	314	301	-	-	-	-	-	-	055	040
20N	015	332	305	292	-	-	-	-	-	-	064	048
10N	020	323	295	283	-	-	-	-	-	-	074	057
0	030	310	285	273	-	-	-	-	-	-	083	069
10S	052	290	273	263	-	-	-	-	-	-	094	084
20S	104	261	259	254	-	-	-	-	-	-	105	100
30S	145	233	245	243	-	-	-	-	-	121	115	115
40S	160	214	232	232	-	-	-	-	-	130	126	131
50S	168	202	220	222	217	-	-	-	-	141	137	144
60S	172	194	208	212	208	-	-	-	-	150	148	156
70S	176	188	197	201	199	192	-	-	165	160	159	165
80S	178	184	189	191	189	186	182	177	172	169	170	173

DUBHE



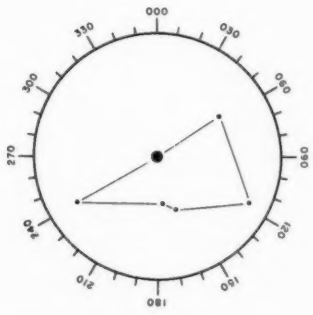
LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	004	012	018	021	019	008	353	341	339	342	348	356
70N	007	020	032	042	047	032	330	313	318	328	339	352
60N	008	026	043	059	075	097	260	284	300	316	333	351
50N	009	030	050	070	095	136	219	264	288	309	328	348
40N	011	034	057	079	107	149	208	251	279	302	325	348
30N	012	037	062	087	115	154	202	243	271	297	320	346
20N	-	-	067	092	121	158	199	236	266	292	318	-
10N	-	-	071	098	126	160	198	232	260	287	-	-
0	-	-	-	103	131	162	196	228	255	-	-	-
10S	-	-	-	-	134	164	195	224	-	-	-	-
20S	-	-	-	-	138	165	193	221	-	-	-	-
30S	-	-	-	-	-	-	-	-	-	-	-	-
40S	-	-	-	-	-	-	-	-	-	-	-	-
50S	-	-	-	-	-	-	-	-	-	-	-	-
60S	-	-	-	-	-	-	-	-	-	-	-	-
70S	-	-	-	-	-	-	-	-	-	-	-	-
80S	-	-	-	-	-	-	-	-	-	-	-	-

ENIF



LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	354	350	350	351	356	000	006	009	010	008	005	000
70N	348	341	340	-	-	-	-	018	020	017	009	358
60N	340	332	330	-	-	-	-	-	030	027	016	357
50N	331	320	320	-	-	-	-	-	041	037	023	356
40N	321	310	310	-	-	-	-	-	051	049	033	354
30N	307	298	300	-	-	-	-	-	061	061	046	350
20N	291	287	291	-	-	-	-	-	070	072	066	340
10N	273	276	-	-	-	-	-	-	081	085	088	270
0	256	265	-	-	-	-	-	-	090	096	110	202
10S	240	254	-	-	-	-	-	-	101	108	127	191
20S	228	244	-	-	-	-	-	-	111	119	139	188
30S	218	234	-	-	-	-	-	-	-	129	148	186
40S	210	225	-	-	-	-	-	-	-	138	156	184
50S	203	216	-	-	-	-	-	-	-	147	162	183
60S	197	207	-	-	-	-	-	-	-	155	167	182
70S	191	-	-	-	-	-	-	-	-	163	172	182
80S	-	-	-	-	-	-	-	-	-	-	-	180

FOMALHAUT



LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	-	-	-	-	-	-	-	-	-	-	-	-
70N	-	-	-	-	-	-	-	-	-	-	-	-
60N	-	-	-	-	-	-	-	-	-	-	-	-
50N	350	332	-	-	-	-	-	-	-	-	027	009
40N	347	327	-	-	-	-	-	-	-	-	033	011
30N	344	320	-	-	-	-	-	-	-	-	039	014
20N	341	313	295	-	-	-	-	-	-	065	046	017
10N	337	305	286	-	-	-	-	-	-	073	053	020
0	330	296	278	-	-	-	-	-	-	081	062	027
10S	320	286	268	-	-	-	-	-	-	091	073	036
20S	301	273	259	-	-	-	-	-	-	101	087	055
30S	266	258	249	236	-	-	-	-	123	111	101	094
40S	228	242	238	228	-	-	-	-	131	121	118	135
50S	207	227	227	219	-	-	-	152	140	133	134	157
60S	195	212	215	211	201	187	172	159	149	145	148	166
70S	188	200	204	201	194	185	174	165	159	157	161	173
80S	184	189	192	191	187	183	177	172	169	168	171	177

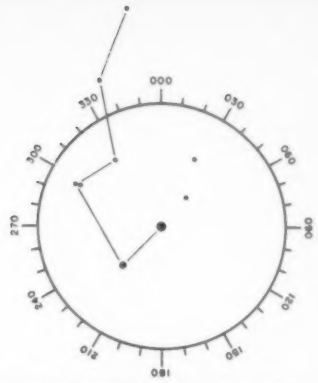
GIENAH

LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	-	-	-	-	-	-	-	-	-	-	-	-
70N	-	-	-	-	-	-	002	351	-	-	-	-
60N	-	-	-	-	-	016	002	347	336	-	-	-
50N	-	-	-	-	035	022	002	342	328	-	-	-
40N	-	-	-	-	044	028	004	338	320	-	-	-
30N	-	-	-	-	053	035	005	333	311	-	-	-
20N	-	-	-	-	061	043	006	325	302	-	-	-
10N	-	-	-	-	072	053	008	315	293	281	-	-
0	-	-	-	-	082	066	012	302	282	272	-	-
10S	-	-	-	101	092	081	026	284	271	261	-	-
20S	-	-	-	110	104	099	119	261	258	252	-	-
30S	-	-	-	120	114	118	164	239	246	242	-	-
40S	-	-	-	129	126	135	172	220	233	232	-	-
50S	-	-	-	139	138	147	175	207	221	222	-	-
60S	-	-	156	149	149	158	177	198	209	212	207	-
70S	-	171	163	160	160	166	179	191	199	201	198	191
80S	180	175	172	169	170	174	179	185	189	191	189	186

HAMAL

LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	007	000	355	350	349	351	354	000	005	009	011	010
70N	014	001	347	340	338	342	349	000	009	017	022	020
60N	024	001	340	330	329	335	-	-	-	023	030	031
50N	036	003	327	316	317	326	-	-	-	033	042	045
40N	051	005	311	303	307	-	-	-	-	-	052	057
30N	071	017	289	290	297	-	-	-	-	-	062	069
20N	091	155	266	278	288	-	-	-	-	-	071	081
10N	109	172	247	266	278	-	-	-	-	-	080	092
0	124	175	233	256	270	-	-	-	-	-	-	102
10S	134	177	222	246	-	-	-	-	-	-	-	112
20S	142	177	215	237	-	-	-	-	-	-	-	121
30S	149	178	208	229	-	-	-	-	-	-	-	129
40S	155	178	203	221	-	-	-	-	-	-	-	138
50S	160	178	198	213	-	-	-	-	-	-	-	-
60S	166	179	192	-	-	-	-	-	-	-	-	-
70S	-	-	-	-	-	-	-	-	-	-	-	-
80S	-	-	-	-	-	-	-	-	-	-	-	-

KOCHAB



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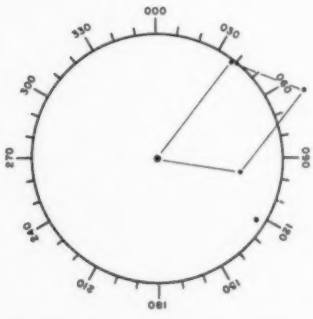
50N	327	350	014	037	062	088	120	162	208	247	277	303
40N	324	350	015	040	066	093	125	164	204	241	271	299
30N	323	349	017	043	070	098	130	165	203	237	268	295
20N	321	349	017	045	073	101	133	166	200	234	265	292
10N	-	-	-	-	076	104	135	167	200	231	262	290
0	-	-	-	-	-	107	137	167	199	230	258	-
10S	-	-	-	-	-	-	139	168	197	227	-	-
20S	-	-	-	-	-	-	-	-	-	-	-	-
30S	-	-	-	-	-	-	-	-	-	-	-	-
40S	-	-	-	-	-	-	-	-	-	-	-	-
50S	-	-	-	-	-	-	-	-	-	-	-	-
60S	-	-	-	-	-	-	-	-	-	-	-	-
70S	-	-	-	-	-	-	-	-	-	-	-	-
80S	-	-	-	-	-	-	-	-	-	-	-	-

MENKAR



LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
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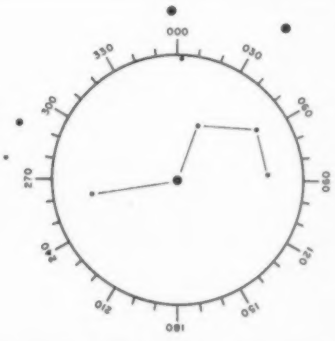
70N	015	006	355	345	340	-	-	-	-	-	-	020
60N	023	009	351	338	330	-	-	-	-	-	-	030
50N	032	014	347	328	320	-	-	-	-	-	-	040
40N	043	020	343	319	311	-	-	-	-	-	-	050
30N	054	029	334	307	300	-	-	-	-	-	-	060
20N	066	043	320	294	290	-	-	-	-	-	-	071
10N	080	068	294	280	279	-	-	-	-	-	-	081
0	094	104	254	266	269	-	-	-	-	-	-	091
10S	107	131	225	252	259	-	-	-	-	-	-	101
20S	119	147	209	240	248	-	-	-	-	-	-	111
30S	131	157	200	228	238	-	-	-	-	-	-	121
40S	141	163	195	218	228	-	-	-	-	-	-	132
50S	150	168	191	209	219	-	-	-	-	-	-	141
60S	158	171	188	201	208	-	-	-	-	-	-	151
70S	165	174	185	194	199	-	-	-	-	-	-	161
80S	172	178	182	186	-	-	-	-	-	-	-	-

MIAPLACIDUS



LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	-	-	-	-	-	-	-	-	-	-	-	-
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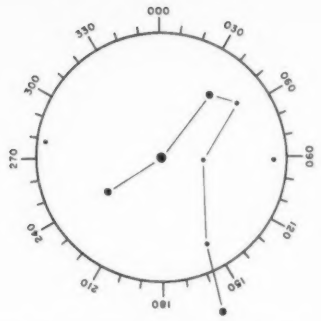
60N	-	-	-	-	-	-	-	-	-	-	-	-
50N	-	-	-	-	-	-	-	-	-	-	-	-
40N	-	-	-	-	-	-	-	-	-	-	-	-
30N	-	-	-	-	-	-	-	-	-	-	-	-
20N	-	-	-	-	-	-	-	-	-	-	-	-
10N	-	-	-	047	018	348	319	-	-	-	-	-
0	-	-	079	049	019	347	316	287	-	-	-	-
10S	-	111	082	052	021	347	314	284	255	-	-	-
20S	141	114	086	056	022	345	310	279	252	225	196	168
30S	143	117	090	060	024	344	307	275	248	222	196	170
40S	146	121	095	066	027	342	302	270	244	219	195	170
50S	148	126	102	073	033	338	293	263	239	216	193	171
60S	152	132	112	087	046	328	279	253	231	211	192	172
70S	158	142	127	113	098	264	250	236	221	205	190	174
80S	165	157	151	150	164	191	209	210	205	196	186	176

MIRFAK



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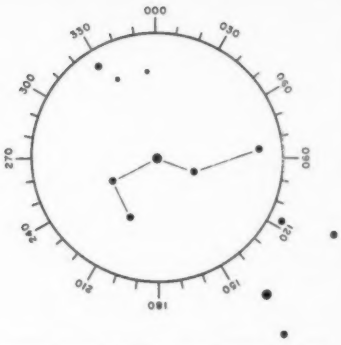
70N	031	018	350	332	328	332	341	352	004	015	025	032
60N	051	041	334	310	312	321	334	350	005	021	034	045
50N	070	082	274	286	298	312	329	347	007	025	042	057
40N	087	118	219	265	286	304	324	345	008	030	050	067
30N	099	135	204	251	277	297	318	-	-	-	056	076
20N	109	145	198	241	269	290	-	-	-	-	062	085
10N	116	151	195	234	261	284	-	-	-	-	-	091
0	123	154	193	228	254	-	-	-	-	-	-	098
10S	129	158	191	222	248	-	-	-	-	-	-	-
20S	134	160	190	219	-	-	-	-	-	-	-	-
30S	-	163	189	214	-	-	-	-	-	-	-	-
40S	-	-	-	-	-	-	-	-	-	-	-	-
50S	-	-	-	-	-	-	-	-	-	-	-	-
60S	-	-	-	-	-	-	-	-	-	-	-	-
70S	-	-	-	-	-	-	-	-	-	-	-	-
80S	-	-	-	-	-	-	-	-	-	-	-	-

NUNKI



LHAT / LAT	0	30	60	90	120	150	180	210	240	270	300	330
80N	-	-	-	-	-	-	-	-	-	-	-	-
70N	-	-	-	-	-	-	-	-	-	-	-	-
60N	-	-	-	-	-	-	-	-	-	007	352	-
50N	-	-	-	-	-	-	-	-	027	009	349	332
40N	-	-	-	-	-	-	-	-	033	012	347	326
30N	-	-	-	-	-	-	-	056	040	015	343	319
20N	294	-	-	-	-	-	-	065	047	017	340	312
10N	285	-	-	-	-	-	-	074	055	022	335	302
0	276	-	-	-	-	-	-	083	065	030	327	293
10S	267	-	-	-	-	-	-	092	077	042	313	281
20S	257	-	-	-	-	-	-	102	091	068	289	269
30S	247	236	-	-	-	-	123	112	107	111	250	254
40S	236	228	-	-	-	-	131	123	123	144	220	238
50S	225	219	-	-	-	-	141	134	137	159	203	223
60S	214	210	201	-	-	159	149	146	151	168	193	210
70S	202	200	194	185	174	165	160	158	162	174	188	198
80S	191	190	187	183	177	173	170	169	172	177	184	188

Navigation North of SEVENTY

Editor's Note: The following article is from "Navigation North of Seventy," authored by First Lieutenant David J. Haney in 1948. Lt Haney compiled his information while a member of the 46th Reconnaissance Squadron in the late '40s. The squadron, flying B-29s, logged over 10,000 hours in two and one-half years over the polar regions. During this time period they tested polar navigational techniques, new equipment, and refined their skills for traversing the Arctic. The article is reprinted verbatim from the original manuscript.

Navigational Aids & Techniques
Radar As An Aid to Navigation in Polar Flying

While the squadron was making preparations for its departure to Alaska, little thought was given to the results to be expected from airborne radar. It was known that in lower latitudes and areas where reliable maps exist, radar is an invaluable aid to the navigator. It was used

during the war with good results in bombing when cloud coverage prevented visual sighting. It was generally known that the maps in the north were unreliable and, if so, radar would be of little value to the navigator. Radar observers were in doubt as to the returns they would get over frozen terrain or the ice of the Arctic Ocean.

In well-mapped areas, radar observers are able to get accurate ground speeds for the navigator by time and distance between successive points. From these the navigator can determine his wind direction and velocity. There was another method familiar to radar observers for obtaining ground speeds, i.e., following an object across the PPI and computing the distance the target travelled and the time. This method they knew would work where there was sufficient return to follow a target for the required period. The big question was will there be enough return from the ice pack to allow them to make an accurate run? Due to the lack of information on what to expect from radar, crews were assigned only one observer.

After the first mission, radar observers were pleased to find that returns from the ice pack were suitable for making wind runs. Leads and pressure ridges gave sufficient targets for them to obtain accurate ground speeds and drifts. The late summer fog over the ice pack prevented visual drifts except for occasional views. These occasional visual drift readings compared with the radar drifts were found to be within a degree of each other most of the time. This of course gave the navigator confidence in the radar drifts and they were used without anxiety as to their accuracy.

Radar's contribution to polar navigation is without doubt responsible for the fact that the Air Force is able to fly over the polar area safely during any season. With present day navigational aids in polar regions, the air crew must be self sufficient. The navigation team cannot depend on any ground installations for help (i.e., radio, Loran or visual pilotage). The long hours required of the observers resulted in eyestrain, which in the case of one man required that he be fitted for glasses. When it became apparent that polar missions could not be successfully carried out without the use of radar, two operators were assigned to each crew and the mission was aborted if the equipment became inoperative.

If a navigator attempted to fly to the pole from Point Barrow in midsummer without the aid of radar, he would be forced to rely on sun lines alone for position determination. It is impossible to obtain a fix from a single celestial line of position; therefore, the navigator would never know just where the aircraft was on that line. During the summer months, fog on the ice prevents visual drift reading so much of the time that he would have only astro headings, true airspeed and sun lines for position determination. With such scanty information he could not possibly carry on the precision dead reckoning that is required in polar flying. With radar reporting at least two drifts and ground speeds an hour, the navigator is in a position to accurately deduce his "most probable position" when comparing a dead reckoning position with a sun line.

Interpretation of Sun Lines

During the summer months the navigator is never in a position, except when the moon is up with a sufficient azimuth difference for a fix, to give an exact position. In the winter this is no problem above 70 degrees as the sun never rises and stars are visible continuously. When only the sun is available for positioning, some method must be adopted to make the best possible use of the information offered by the single line of position.

A majority of the navigators of the 46th use what they call "dropping a perpendicular." This is done by keeping the most accurate dead reckoning possible, then plotting sun lines and moving a line perpendicular to the DR position. (Fig. 1). This gives full credit to the sun line as being accurate and the dead reckoning in error. Other navigators prefer to balance out errors by giving some credit to the DR and allow for some error in the sunline. These navigators usually choose a point midway between the DR position and the sun line as their most probable position.

The overall result of combining radar information and sun lines, the ETA error at land fall for approximately 1274 hours of flying over the polar sea, is 6 minutes and 8 miles.

The backers of the method of dropping the perpendicular all the way to the sun line and those who prefer dropping only half way had an interesting argument, each in defense of his belief. One of the navigators who preferred the half way method had just been complaining that on a recent flight of his the course and ETA error was greater than he thought it should be. This argument led to the replotting of his mission and dropping the DR all the way to his sun line. The outcome of this replot was that his ETA and course at landfall would have been less than half

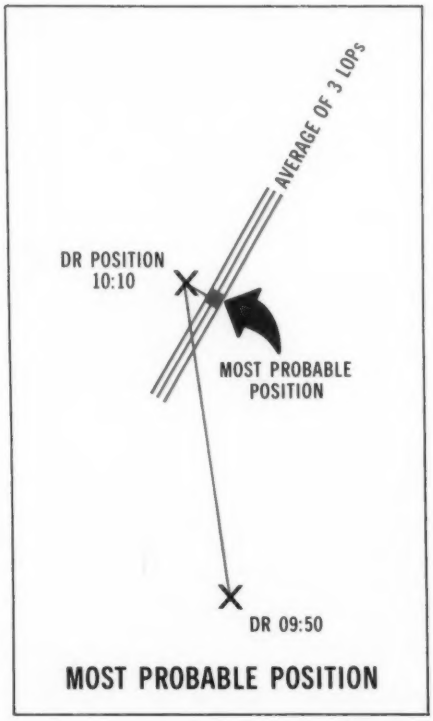


Figure 1

what it actually was had he dropped all his DR positions to the sun lines.

Dead Reckoning Versus Celestial Line of Position

The basic argument for the two methods is where is the greatest possibility of error going to be? The expected accuracy from celestial sights in an aircraft is not less than five miles. The proficiency gained from constant use of the sextant by the navigatorsof the 46th gives them confidence in their sights. Time errors are not of greatest importance in polar latitudes as in the tropics. An error of twenty seconds in time is equivalent of an error in longitude of 5' arc, and this is true for all latitudes. At the equator, however, 5' of longitude is equal to 5 nautical miles, but in latitude 80 degrees, due to the convergence of the meridians, it is equal to 0.85 nautical miles, and in latitude 85 degrees to 0.45 nautical miles. Stated differently, if a time error of 20 seconds can be tolerated at the equator, one of approximately 120 seconds can be tolerated at latitude 80 degrees, and one of approximately 220 seconds at latitude 85, since all will result in the same linear error in longitude.

Navigators' watches and chronometers are usually within a few seconds of correct on all flights, and if their proficiency with the sextant is average, it is reasonable to assume that they can obtain sun sights within the desired 5 miles of accuracy. The novice may be inclined to lean more toward his dead reckoning than the more experienced polar navigator. It is known that in lower latitudes with so many available aids the navigators seldom use their sextants. The polar navigator by contrast believes and uses his sextant continuously. He knows the error on the instrument by constant checks, and a hundred sights on a fifteen hour flight over the polar sea is not unusual. Obviously this constant use of the sextant with good results will give him the highest degree of proficiency and confidence.

By giving more weight to the DR position than the sun line there is more chance of error due to several factors. The indicated air speed of the B-29 varies with weight and power settings made by the flight engineer. Strict cruise control must be practiced on long polar flights to meet any emergency that may arise. To keep up with the indicated airspeed accurately would in itself be almost a full time job. Even though engineers always warn the navigator of power changes, it is not unusual to see the airspeed changed by several miles per hour from the last reading. There is no way for the navigator to know how long this change has been in effect; therefore, he can only assume it from the time he saw it. This change will result in an erroneous true airspeed; consequently the ground speed will be higher or lower, as the case may be.

Changes of wind direction in the polar regions are frequent and often violent; the drift may be 5 degrees right at a given time and a few minutes later 15 degrees right. There is no way of knowing when this change occurred; therefore, the plot could easily be in error.

While radar is the only reliable means of determining drift and ground speed at any time in the polar sea, it is not the desired instrument that navigators dream of—one that will give a constant indication of drift and ground speed. Of necessity there is a time interval between successive wind runs. It is during this interval that the navigator has no way of knowing what effect the wind is having on his DR. Of course, if the drift changes only a degree or so between successive wind runs, he can be reasonably sure that during the time interval he had the same drift. Some of the above mentioned circumstances are rare, to be sure, but they do sometimes happen and there is no way of predicting when they will occur.

COMMAND DAY

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MATHER AFB, CA

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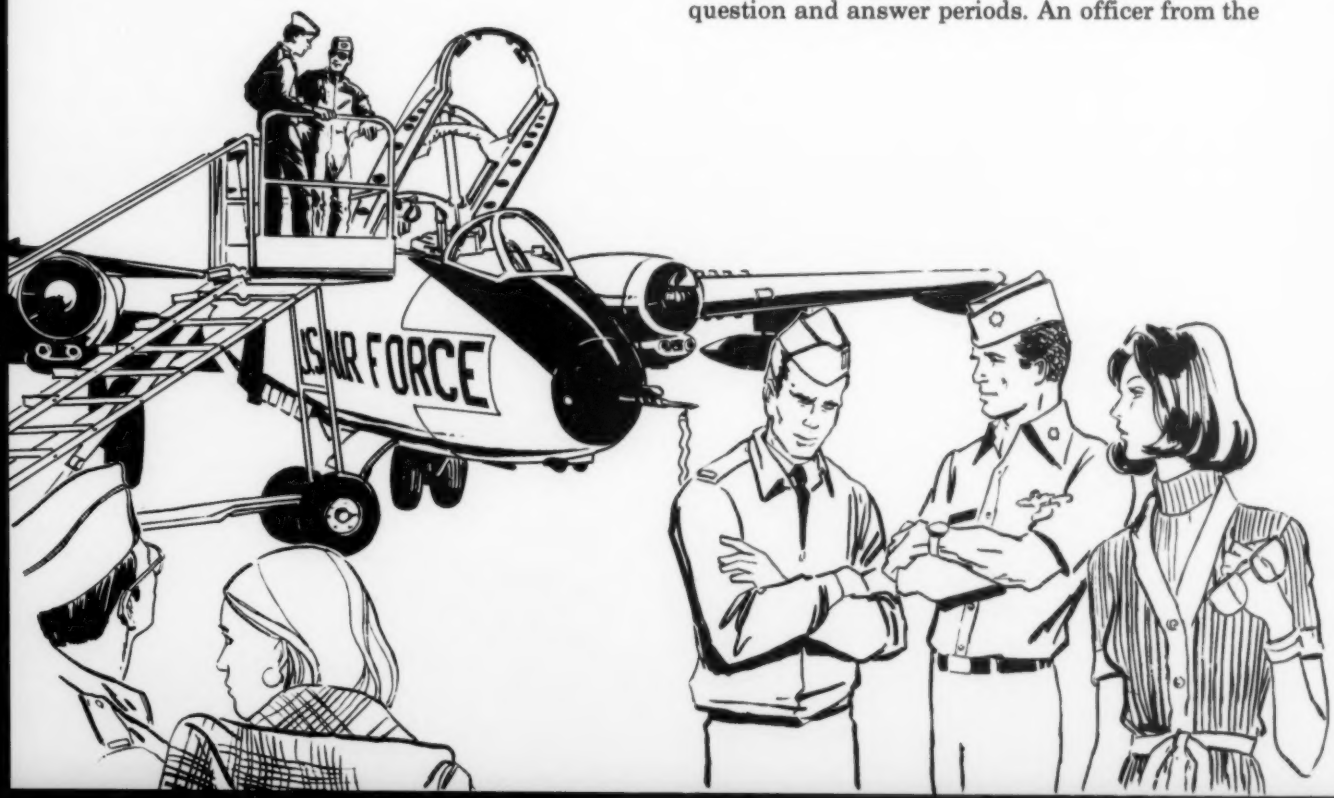
323 FTW/DOD
MATHER AFB, CA

"Command Orientation Day comes to Undergraduate Navigator Training at Mather AFB." That was the theme in the fall of 1970 when the first Command Orientation Day took place. It has since blossomed into a major event which occurs three times a year.

With the expansion of the navigator's role during the SEA conflict, a communication vacuum developed between Undergraduate Navigator Training (UNT) students and MAJCOMs concerning these expanded roles. At the time, navigation was still being taught in the T-29, yet graduates were receiving assignments to modern sophisticated jet aircraft. It became evident that the officers in UNT needed more information on their expanded assignment possibilities. Realizing the need for a career development program for UNT students, the Deputy Commander for Navigator Training established Command Orientation Day to acquaint the students with their future flying jobs. To accomplish this task, he requested that SAC, TAC, and MAC send their briefing teams and provide a static display of aircraft to which navigators were assigned.

The primary function of Command Orientation Day (also known as Command Day) is to explain to the UNT student the present and future roles of the navigator in the using MAJCOMs. A satellite objective is to motivate the student and, in teaching him about the roles of the MAJCOMs in supporting the Air Force mission, provide him with some information to begin his career-planning process.

Command Orientation Day is held on the first Friday of April, August, and December and begins with a series of briefings followed by an aircraft static display. Each UNT student is scheduled to attend this event prior to submitting his assignment preferences. Wives are also encouraged to participate. During the morning session, the students attend all three major command briefings, which are followed by question and answer periods. An officer from the



personnel section of each major command accompanies the briefing team to answer questions concerning assignment policies and procedures. The navigators who crew the aircraft brought in for the static display are also available during this time. Following the briefings, everyone heads out to the flight line to view the aircraft on static display.

A typical display consists of aircraft representing each major command: MAC is represented by the C-130 and C-141; SAC, the B-52G, KC-135, and FB-111; and TAC, the F-4, RF-4, F-111, and F-105. For many of the navigator students, this is one of the first opportunities to closely view the aircraft which they will be flying in the near future. It is also their first exposure to the avionics peculiar to operational weapon systems.

Through informal discussions with the operational navigators manning the displays, many of whom are recent UNT graduates themselves, the students get an accurate picture of the life of a junior officer fulfilling rated duties in SAC, MAC, and TAC. This interchange has proven to be one of the most worthwhile parts of the Command Day schedule. At 1600 the display closes and the Command Day program ends. Although the day's briefings are specifically oriented toward UNT students and their dependents, the static display is open to all base personnel and their guests. Following the day's activities, students complete questionnaires to give their impressions of the program and to offer suggestions for improvement.

Student feedback on the effectiveness of the Command Day program has been most favorable. Comments indicate that the program is successful in giving insight into the duties, aircraft, and working conditions which the student will encounter following UNT graduation. This program helps the student plan his assignment preferences, especially if he desires an assignment according to a particular location, aircraft, or command. Command Day briefings and discussions inform the student of MAJCOM operational philosophies and missions and cover life in the MAJCOMs outside ATC. The Command Day program also affords the students' spouses an excellent opportunity to learn about the Air Force and MAJCOM missions in general and the particular jobs their husbands will be performing in the future. Command Day is an informative experience which fosters a better understanding of Air Force life among the wives.

For many of them, this program is their first formal introduction in this area.

Last year the Command Day program was expanded to include the officers in Electronic Warfare Training (EWT). Command Day allowed these officers to view various aircraft, their systems, and the manner in which they support major command missions. This complemented EWT objectives and expanded the career planning phase of Command Day to include this important segment of the navigator resource. Electronic Warfare Officers assigned to the B-52, F-105, EB-57, and DC-130 brief the students on their duties and provide further command orientation. After these briefings, the EW student is encouraged to view the aircraft on static display. Since the EWT program encompasses all services, briefings on the electronic warfare missions of the sister services are occasionally included. The Navy supports this program by providing briefing crews and an EA-6B Intruder for static display.

With the advent of Interservice Navigator Training (Mather now trains Air Force, Navy, Coast Guard, and Marine Corps students), Command Day was expanded to include programs of interest to these students from the other services. Since most of the Navy graduates are assigned to the P-3 Orion, Patrol Squadron 31, NAS, Moffett Field, CA, provides a P-3 for static display and an orientation briefing for Navy officers and their spouses.

The objectives of Command Orientation Day will be further enhanced in the near future by the addition of an information library on Air Force bases located in the US and selected overseas bases. Each UNT squadron will soon have such a library.

Command Orientation Day is indeed a major event in training navigators at Mather AFB and provides each officer with important career planning information. It adds a dimension to navigator training which would be hard to duplicate by other means. The outstanding support provided by the major commands, their crew members, and Mather's organizations greatly enhances this aspect of student training. The entire Air Force can be proud of this program.

Capt Nikolai graduated from the University of Wisconsin in 1967. Following UNT, he served as a navigator in AC-47 gunships and Cessna 0-2As during his SEA tour. Instructor duty has included C-141s and three years in UNT, followed by his present duty as Flight Commander, 450th Flying Training Squadron. Capt Nikolai has participated in Command Orientation Day for three years and has headed this project for over one year.

Capt Soteropoulos graduated from the Air Force Academy in 1969. He served as an Orbital Analyst in the Space Defense Center at Cheyenne Mountain, CO, followed by Undergraduate Navigator Training at Mather AFB. On his next assignment, he flew C-141s out of McChord AFB. In 1974, Capt Soteropoulos completed a SEA tour in the EC-47. He is presently assigned to Mather AFB as Executive Officer, 450th Flying Training Squadron.

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